The Impact of Oil Revenue on the Iranian Economy

Ronak OLFATI

Submitted for the Degree of

Doctor of Philosophy

Faculty of Social Sciences

University of Bradford

2018

Abstract

Ronak Olfati

The Impact of Oil Revenue on the Iranian Economy

Keywords: economic growth, natural resources, oil income, autoregressive distributed lag, vector error correction modelsThis study aims to identify the effects of oil income on economic growth in Iran over the period 1955-2014. The empirical literature indicates that countries with natural resources are growing more slowly than their counterparts. However, the results from this literature are far from conclusive, particularly in regard to the role played by oil-rich countries. Needless to say, this role depends on other factors as well, including the political situation in the country, the quality of institutions, and the efficacy of the financial system. Some empirical research has found that natural resources, particularly oil, can have a positive impact on the output of a country. although natural resources are not a factor of production in growth theories, studies have used different growth frameworks in order to discover whether having natural resources is a blessing or a curse.

In line with recent studies, this work uses an augmented neoclassical growth model to develop a theoretical framework where oil enters the long-term output of the country through saving and investment. Overall, the results suggests that oil income has a positive impact on the level of output per capita in Iran. The findings of the econometric results are in line with the historical analysis of the study. Since different methods and proxies were used, a total of eight models were estimated. Interestingly, when PRIVY is used as an index of financial development, the result of the study changes and oil no longer has a significant impact on the economy. However, this can be translated to an inefficient allocation of credit to the private sector.

Acknowledgements

Firstly, I would like to express my sincere gratitude to my supervisor Dr Hossein Jalilian for the continuous support of my PhD study and related research, for his patience

kindness, understanding and immense knowledge throughout my thesis.

I also wish to thank Professor Behrooz Morvaridi, for his help and support during different stages of the programme, and to all the staff of PSID.

Without the immense love, support and encouragement of my mum and dad, I would never had got to where I am today. For that, I will always be greatly appreciative. I also extend these words to the rest of my family.

I would like to register special appreciation and heartfelt gratitude to my husband, for his tremendous support and patience.

High praise is reserved for all my friends, in particular those in the ‘Cecil Castle’ who have always helped me in times of crisis, provided great encouragement and cheered me up with humour of fine quality.

The support and help received from all my colleagues at the PSID are also very much appreciated.

Dedication

To my parents Robabeh and Alireza

Table of Contents

List of Figures

List of Tables

Abbreviation

ADF	Augmented Dicky Fuller
AIC	Akaike information criterion
AIOC	Anglo Iranian Oil Company
APOC	Anglo Persian Oil Company
ARDL	Autoregressive Distributed Lag
ARMA	Autoregressive Moving Average
BERI	Business Environmental Risk Intelligence
BGP	Balanced Growth Path
BP	British Petroleum
CFP	Compagine Francaise des Petrol
CIA	Central Intelligence Agency
CPI	Consumer Price Index
CRS	Constant Returns to Scale
DW	Durbin-Watson
ERP	Economic Rehabilitation Plan
GDP	Gross Domestic Product
GMM	General Method of Moments
GNP	Gross National Product
ICRG	International Country Risk Guide
IEA	International Energy Agency
IMF	International Monetary Fund
IR	Iranian rial
KPSS	Kwiatkowski-Phillips-Schmidt-Shin

NIOC	National Iranian Oil Company
OAPEC	Organization of Arab Petroleum Exporting Countries
OECD	Organisation for Economic Co-operation and Development
OG	Overlapping Generation
OLS	Ordinary Least Squares
OPEC	Organization of Petroleum Exporting Countries
OSF	Oil Stabilization Fund
PCA	Principle Component Analysis
PP	Philips Peron
PPF	Production Possibility Frontier
PPP	Purchasing Power Parity
QoG	Quality of Government Institute
R&D	Research and Development
RCK	Ramsey-Cass-Koopmans
RGDPE	Expenditure-side real GDP at chained PPPs
SC	Schwartz *Criterion*
VAR	Vector Autoregressive
VECM	Vector Error Correction
WGI	World Bank Governance Index
WTO	World Trade Organization

Chapter One

INTRODUCTION

1.1 Background of the Study

Measures of gross domestic product are still the key means of comparing living standards across countries. Although each country has its own unique way of achieving a balanced growth path, understanding the general process through which a country can grow over time is of enormous practical importance. For decades, the debate on economic growth has been important, as governments all around the world, in both developed and developing countries, have had to deal with the socio-economic costs of low economic growth. Throughout the history of economic studies, economic growth has always been at the centre of attention since it is a good indicator of how a country is performing in relation to previous years and compared to other countries. A number of factors affect economic growth, including physical capital, human capital, institutional quality, financial development, climate, the political situation and natural resources. However, these are not all the factors that can impact on the economic growth and performance of a country.

Among the aforementioned factors, natural resources are particularly interesting: until the 1930s, natural resources were seen as the engine of economic growth for industrial countries. The study of the association between natural resources and economic growth goes back to the early economists such as Adam Smith and David Ricardo. Their belief was that natural resources were a blessing for countries, so that their development could be based on natural resources endowments. Therefore, in the 19th century, many neo-liberal economic scholars believed that possessing natural resources was a privilege for a country. It could be said that some of today's industrial and developed countries, such as the United States, Canada, Australia and the United Kingdom, used their natural resources to transform themselves from developing to developed countries. However, in the twentieth century this role has changed and natural resources are considered a curse.

It is important to mention that resource curse studies concentrate mainly on the short-term and negative impact of natural resources on economic growth. The resource curse hypothesis was the outcome of resource-poor countries being outperformed by their counterparts. It is worth mentioning that some studies in the twenty-first century have come to the different conclusion that natural resources can have a positive impact on the economic growth of resource-rich countries. These more recent studies focus on the long-term role of resource endowments.

Because of the ambiguity of outcomes, diversified results and contradiction of the conventional wisdom, the resource curse came sharply into the research focus, attracting a vast amount of scientific attention. Although the relationship between natural resource abundance and economic growth has been widely studied in the literature, there are different views on this issue. In terms of growth theories, it was concluded that the standard growth theory is not automatically applicable in explaining growth in resource-abundant countries. Solow (1994) states that all the theoretical frameworks of growth are based on assumptions that are valid for mature industrial economies. Although natural resource endowments do not play any role in the existing growth theories, the role of natural resources in the economy has been studied through some growth theories.

A significant literature developed on the negative relationship between natural resources and economic growth in the twentieth century. Auty (1993) coined the phrase “resource curse” and this so-called “resource curse” continues to receive a lot of attention from researchers. An econometric study testing this hypothesis was initiated by Sachs and Warner (1995a). They confirmed the existence of the resource curse by studying a large cross section of countries. The literature has grown considerably over time. Economists and political scientists have recognized various causal channels through which the resource curse might happen. Broadly speaking, these channels can be divided into political and economic ones. Among the economic channels, the Dutch Disease and volatility are the most common ones, while political economic channels comprise corruption, a lack of democracy, civil war, rent-seeking activities and poor-quality institutions.

In 1977, The Economist coined the phrase “Dutch disease” to explain that the discovery of large gas reserves in the Netherlands in the 1960s led to a significant decline in the competiveness of its other, non-booming tradable sectors. With the Dutch Disease in the Netherlands, the belief in the negative association between resource abundance and economic growth grew stronger and new literature emerged (Gregory 1976; Snape 1977; Corden and Neary 1982; Corden 1984; Neary and Van Wijnbergen 1986). Sachs and Warner were motivated by the above-mentioned studies and launched a series of cross-sectional studies that confirmed an inverse association between natural resources and economic growth (Sachs and Warner 1995a; Sachs and Warner 1997; Sachs and Warner 2001).

Van Der Ploeg and Poelhekke (2009) reject the resource curse hypothesis based on cross-country evidence. They demonstrate that it is the volatility of the prices of natural resources that causes the so-called “resource curse”. Here in this research we are looking at oil as a particular natural resource and one important feature of the oil market is volatility, which turns out to play a significant role in the resource curse hypothesis. Oil prices by nature are very volatile; therefore, the income from them fluctuates. Thus, for a country where resource rents are the main source of income, dealing with fluctuations in this income is a challenge. Nonetheless, appropriate policies from government can act as shock absorbers, negating the adverse impact of volatility (see (Hausmann and Rigobon 2003; Van Der Ploeg and Poelhekke 2009).

Moving further along the spectrum from economic science to political science, there are political explanations for the resource curse, such as rent-seeking activities, corruption, civil war and voracity. Many scholars, such as Gylfason (2001), Hodler (2006), (see(Lane and Tornell 1996; Leite and Weidmann 1999; Torvik 2002; Collier and Hoeffler 2004; Robinson et al. 2006), indicate that in some states the money from resources gives more power to elites, who can widen the inequality in the country. In addition, in political economy there is a growing literature about the role that institutions can play in utilizing the income from resources (Mehlum et al. 2006a).

Both the approach and the results of resource curse research have been criticized on a number of grounds. Brunnschweiler (2008) points out that the measure that Sachs and Warner used in their research indicates resource dependence rather than resource abundance. Brunnschweiler (2008) says that if resource abundance is used instead of resource dependence, natural resources have a positive impact on growth. In line with Brunnschweiler results some studies, such as Esfahani et al. (2013), Cavalcanti et al. (2011a) and Alexeev and Conrad (2009), demonstrated that their findings are in contrast to the literature on the resource curse and the Dutch Disease.

In general, the literature on the resource curse hypothesis can be divided into three categories. The first group, following Sachs and Warner, confirms the negative association between natural resource endowments and economic performance. The second group explains the resource curse through political economy. The third group, in contrast to the resource curse hypothesis, indicates that there is a positive link between natural resources and economic growth. It should be mentioned that in this thesis, by natural resources we mean oil endowments, and by economic growth we mean the level of output per capita. These terms are used interchangeably in this research.

1.2 Problem Statement

This study aims to identify the effect of oil export revenue on economic growth in Iran during the period 1955-2014. Oil export income in Iran comprised over 80 per cent of the government budget in the last four decades so it became necessary to investigate its effects on the economy. However, in order to use oil income appropriately, other factors such as financial development and political economy are important. Therefore, this study uses different proxies to take into account the role that the financial system plays in the economic growth of Iran. In terms of political factors, the author believes that these are apparent in the level of equilibrium of capital stock and affect the steady-state growth of the country.

As indicated earlier, most of the empirical studies on natural resources and growth have looked at the revenue from resources as a temporary income. There is a scarcity of research on the long-term impact of natural resources on economic growth. The literature indicates that the effects of natural resources on growth have changed over time: something that was a privilege in the 1960s turned out to be a curse in the 1970s. However, it is worth mentioning that the so-called "resource curse" has been criticized and has given rise to a number of studies that found a positive association between natural resources and economic growth. In terms of econometric approach, the majority of studies looking at natural resources and growth apply a cross-sectional method, which does not take into account social, political or even economic differences in countries. Therefore, it seems more appropriate to analyse the impact of natural resources, particularly oil, on an "energy superpower" country in the long-term. Based on the discussion above, this study aims to achieve the following objectives.

1.3 Objectives of the Study

1.3.1 Main Objective

To identify the effects of oil revenue on the output per capita in Iran over the course of the period 1955-2014, and to determine whether oil revenue has affected growth in Iran positively or not.

1.3.2 Specific Objectives

i) To ascertain whether oil income has been a blessing in contrast to the resource curse hypothesis.

ii) To determine whether oil revenue enters the long-term output of the country with a positive coefficient.

iii) To investigate whether the financial system contributes to the economic growth of Iran.

iv) To specify how the interaction between financial development and oil revenue affects the economy.

1.4 Research Questions

The theoretical and empirical studies on this topic have remained very much a work in progress. Consequently, a number of central questions remain to be answered in the natural resource abundance and growth linkage literature, including: What impact does natural resource income have on long-run and short-run economic growth? Under what conditions can revenue from natural resources enter the long-term output of a country? Is there any potential role for natural resources in growth theories? How can financial development impact on economic growth in a developing resource-rich country? How can the government negate the adverse impacts of volatile oil income? Accordingly, this research aims to re-examine the various aspects of the association between natural resource abundance and economic growth and to answer the aforementioned questions.

1.5 Methodological Framework

In order to investigate more accurately the effects of petrodollars on economic growth, it is necessary to have a theory to decide on the variables of the study. However, the traditional models of growth mainly focus on two key factors as drivers of growth: technology and capital accumulation. Therefore, the potential role of natural resource endowments, particularly oil, is ignored in the growth literature. In addition, the literature deals with the economic growth of countries rich in resources from a different perspective, looking only at temporary discovery of resources. Most of the empirical work in the literature tends to follow Sachs and Warner (1995a) cross-sectional specification, which shows a negative relationship between natural resources and economic growth.

This study takes a different approach by using an augmented neoclassical model where the income from oil enters the long-term output equation. In essence, in a country like Iran, where oil has been produced for over a century, petrodollars enter the saving equation of the economy. A fraction of saving is used as financial intermediation and the rest is invested. Therefore, oil revenues enter the capital accumulation process. In other words, the capital accumulation function consists of two parts: one part is investment from non-oil output and the other is investment from oil output. Following this theoretical framework, the data will be tested using econometric approaches. The data sources for all variables in the study are as follows:

The output per capita is from version 9 of the Penn World tables. The study also checks the data on output on the World Bank website. Data related to oil (prices, production and revenue) are all from the OPEC website. Data on volatility have been calculated by the author based on the oil prices from OPEC. All other data are from the World Bank's World Development Indicators (electronic format). It is worth mentioning that two important events –revolution and war – happened in the course of the study and these are considered a dummy variable.

In regard to data analysis, an econometric technique will be employed, which corresponds to regression analysis, particularly co-integration models. Two different models will be estimated for testing the hypothesis of the study: first, we estimate ARDL models using output per capita as the dependent variable, and our independent variables are oil income, financial development (four different proxies) and a dummy variable that takes into account the political crises of Iran, war and revolution. The results indicate that oil income had a positive impact on the output per capita of Iran during the period 1955-2014.

It is worth mentioning that the rise in the real exchange rate was accompanied by a rise in real output, which does not support the Dutch Disease hypothesis and resource curse. While the growth literature expects positive impact on economic growth the proxies of financial development in Iran, interestingly, does not comply. However, this is not surprising given the isolation of the financial system in Iran and its inefficiency. The political crises in the country also had a negative and significant impact in all models.

Following that, we estimated another co-integration model using the VECM approach. This time we added the interaction between financial development and oil revenue and also volatility as a weakly exogenous variable. The results of ARDL and VECM estimations were in line and indicated that oil income impacts on the output per capita of Iran positively in the long run. Financial proxies similar to the ARDL results did not show any positive impact on the level of output per capita; moreover, the interaction between the financial system and oil revenue has a negative impact on the economy. The political crises that were taken into account through a dummy variable have a significant negative impact on the economic growth of the economy.

1.6 Problems and Limitations

The main challenge that this thesis faces is dealing with data due to the lack of availability of reliable data in the course of the study. In fact, one problem is the unreliability of data, since the Iranian government sometimes resists releasing economic data. For instance, the Central Bank of Iran reveals a lower rate of inflation than the real rate just to pretend the economy is doing well. The official exchange rate is different from the exchange rate that is used in the free market, and the rate in the free market is largely used in the Iranian economy. In other words, the free market has been the dominant source of currency exchange. However, it is almost impossible to obtain reliable data on the exchange rate in the free market. Another problem is that during Ahmadinejad's presidency, data on the main economic indicators became confidential. Therefore, for the years from 2000 to 2008 a lot of data are missing.

Furthermore, the quality of data is not optimal for most developing countries like Iran, which could lead to an unreliable outcome from an econometric modelling point of view. As a result, the study's outcomes should be treated with caution. Lastly, we hope the aforementioned challenges are not sufficiently serious to invalidate the researcher's work.

1.7 Main Results

The co-integration results demonstrated that there is a long-term relationship amongst the variables of the research. The study finds a positive effect of petrodollars on the level of output per capita in Iran. In other words, the econometric results are in line with the theory and historical data, which indicate that oil income enters the long-term output equation of Iran. These results are in contrast to the so-called “resource curse” and “Dutch Disease”, where the incomes from resources are considered temporary. The impact of the financial system on output was not positive, which is in contrast to the growth literature. This illustrates the underdevelopment of the Iranian financial system. In addition, the outcome indicates that the interaction between oil income and financial development influences the output per capita negatively. The results of the study are in line with the work of Esfahani et al. (2013) and Mohaddes and Pesaran (2013).

1.8 Structure and Overview of the Thesis

This research is structured in three parts. The first part, which includes Chapters Two and Three, concentrates on analysing and reviewing the existing literature both on growth theories and the resource curse hypothesis. The background part (second part) of the thesis is presented in Chapter Four, which deals with the economic performance of Iran historically, focusing on oil. It studies the economic performance of the country in different sub-periods: I) oil discovery and oil production in commercial quantities; II) the Islamic revolution and subsequent eight-year war with Iraq; and III) changes in the economic system after the revolution. Chapters Five and Six, which comprise part three, introduce the theoretical framework and the methodology that is employed to estimate econometric models and test the theory empirically. Additionally, this part offers new insights into the theoretical model by suggesting that some of the income from oil will be invested in the economy. Furthermore, the econometric models take into account the roles that volatility and the financial system can play in the economy. There are some concluding remarks and policy recommendations in the last chapter.

More specifically, Chapter Two reviews the literature on economic growth, taking a historical perspective. This chapter is concerned with theoretical models of growth. At the beginning, the Harrod-Domar growth framework is presented. This is followed by neoclassical frameworks, in particular the Solow growth model (Stochastic Solow and Augmented Solow), and then endogenous frameworks. This chapter summarizes different growth theories. Although the potential role of natural resources in the process of growth is ignored, the objective of the chapter is to review all the aforementioned growth theories critically in order to choose a theory that meets the aim of this study. The purpose is to assess which theory fits our goal to investigate the impact of oil revenue on the Iranian economy.

Following that, Chapter Three explores the link between economic growth and the resource curse hypothesis. Based on the existing literature, it provides an overview of the role that natural resources have played in the economic growth of resource-rich countries. The role that natural resources play in the economy is studied through two different channels: economic channels and political channels. This chapter also surveys a large body of literature that has employed different econometric approaches, such as that of Sachs and Warner and their followers, and researchers who have also used the Augmented Solow models applying VAR, VECM or panel methods.

Chapter Four provides a descriptive analysis of the Iranian economic history focusing on oil during the period 1955-2014. This chapter also investigates the process of oil industry development in Iran. It starts from the time when oil was discovered and produced in commercial quantities until 2014. The chapter discusses different phases that the country has faced both before and after the Islamic revolution, the eight-year war with Iraq and severe economic sanctions due to the nuclear plan of the country. In addition, Iran's development plans will be discussed since the economic targets of the country are usually met through these development plans. This assessment gives a historical overview on how the economy has developed over time. Moreover, it shows the role that oil has played historically in the Iranian economy from its discovery until 2014.

Chapter Five is devoted to addressing the selection of the theoretical framework. This chapter introduces a theoretical framework based on the neoclassical growth model, where the impact of oil revenue on economic growth and development occurs in the context of the production function of Cobb-Douglas and time series analysis. The theoretical framework indicates that since oil has been produced for a long time in Iran, it can enter the production function. According to this theory, some petrodollars are saved, and apart from a specific proportion of this saving, the rest is invested. Thus, oil income enters the capital accumulation function through investment. In addition, Chapter Five has an introductory section explaining the nature of the data and time series. The data used for this study are output per capita, oil revenue, four different proxies for financial development (depth, credit, PRIVY and a new index using principal component analysis), volatility, the interaction between oil revenue and financial development and a dummy variable. The data set, data definition and preliminary test for econometric analysis are presented in this chapter as well.

The econometric work in this study is set out in Chapter Six. This chapter justifies the econometric approach of the study and estimates econometric models. The chapter proceeds with an empirical investigation of the role of oil income in the Iranian economy. It examines the long-term and short-term impacts of oil revenue on the Iranian economic growth over the period 1955-2014 applying co-integration models. The results are in contrast to the resource curse theory, which only takes into account the short-term impact of natural resources. Two different econometric approaches are applied in this chapter.

The first approach is the ARDL method to show the effect of oil income on output per capita. Four different models have been estimated and three of them confirm the positive effect of oil on the level of output per capita in Iran. The only model that does not confirm the positive impact of oil is the model where PRIVY is a proxy for financial development. This can be translated into the inefficient credit provided for the private sector in Iran.

Then VECM approach is used in order to estimate the association between the variables of the study. In the VECM models, volatility is added as a weakly exogenous variable. Moreover, through an interaction term, the impact of oil revenue and financial development is studied. Similar to the ARDL models, four proxies are used for financial development. The results are in line with the outcomes of ARDL models, confirming the positive impact of oil on output per capita apart from in the model where PRIVY is an index of financial development. In general, both approaches demonstrate that oil revenue has a positive impact on the level of output per capita. Contrary to the growth literature, the financial system in Iran does not contribute positively to economic growth. In addition, in all models the dummy variable has a significant negative impact on the performance of the economy. Both volatility and the interaction between financial development and oil revenue have a negative impact on the level of output per capita.

Chapter Seven concludes and highlights the main findings and results of the study. In general, the notion that natural resource endowments lead to poor economic performance cannot be true for all countries rich in natural resources. In addition, in the case of Iran, it is concluded that, looking at the long-term, oil has been a blessing for the country and has affected economic growth positively. It is worth mentioning, contrary to existing literature on financial development and growth, that the financial development in Iran has a negative impact on the economy. This is not surprising due to the isolation and limitation of the financial system in Iran. Finally, some policy recommendations and areas for further research are introduced in Chapter Seven.

Chapter Two

A LITERATURE REVIEW ON ECONOMIC GROWTH

“If God had meant there to be more than two factors of production, he would have made it easier for us to draw three-dimensional diagrams.”

(Solow 1956)

2.1 Introduction

Ever since economics has been a profession, economic growth has been one of the main concerns of economists. Economic growth tells us a lot about the economic climate of a country, and also countries are categorized in the world according to their rate of growth. According to Kuznets (1973), economic growth is a long-run increase in the ability of a country to provide goods and facilities to its population. He also states that this increase in ability should be in line with institutional alterations or advances in technology. Therefore, it can be concluded that economic growth is the efficient use of resources in a country to produce goods and services. In other words, economic growth implies rises in per capita output.

The large income differences among countries created a need for concrete economic growth models to guide policies pursuing economic growth. This explains the large body of literature on economic growth (Solow 1956; Romer 1986; Lucas 1988; Weil 2005). As pointed out in the previous chapter, the main objective of this study is to analyse the impact of oil income on the Iranian economic performance. The method is to implement a growth-accounting model, where growth is the measure of economic performance. To this end, it is necessary to choose a growth framework that can fulfil this task, and to do so, this chapter reviews various growth frameworks.

Beliefs and theories on economic growth go back to the classical economists of the eighteenth and nineteenth centuries. It can be said that thoughts on economic growth began with Adam Smith's "An Inquiry into the Nature and Causes of the Wealth of Nations". While Smith did not develop a long-run growth model, he emphasized the significance and effects of increasing labour productivity alongside saving and technical progress. Both Adam Smith and David Ricardo, the early scholars in economics, provided the basics for the current growth frameworks. Smith indicates that productivity is the engine of economic growth, and in his view, productivity was the outcome of the division of labour.

During the industrialization process in 1817, Ricardo published "On the Principles of Political Economy and Taxation". Due to the rapid progress of technological change, he had to rewrite the technology part in 1821 for the third edition. Ricardo considers a two-sector economy with constant returns to scale in manufacturing and diminishing returns in the agricultural sector. He assumes capital owners are the "productive class" since they use their profit in the capital accumulation process. However, this process cannot go on forever because of the population growth. The profit will decrease until it reaches almost zero. At this point, the economy will reach its steady state. Ricardo came up with the notion of diminishing returns to scale and claimed that higher investment will lead to a less than proportionate increment in output; therefore, at some point growth will come to an end.

A few decades later, economic growth was a central theme in Karl Marx's studies. According to Marx, production is closely linked to reproduction. Furthermore, he differentiates saving from consumption and considers depreciation and technological development in order to develop a framework for physical capital accumulation. Marx developed a theory of medium-run development, which can be seen as a first step toward modern growth models.

Up to the twentieth century and well beyond, there was not much progress in growth theories apart from by Schumpeter, who stressed the role of innovation and technical progress. Roy F. Harrod was one of the first economists to focus on the rate of growth and developed a theory built on the work of John Maynard Keynes, which sets the foundation for long-run equilibrium growth. Subsequently Evsey D. Domar focused on the importance of dynamic equilibrium in long-term growth. Since the Harrod and Domar models have similarities, they are usually referred to as the Harrod-Domar model, which is considered an intermediate step between a classical and a neoclassical model.

While economic growth has been a central part of economics at least since Adam Smith, advanced investigation of economic growth using formal frameworks emerged in the twentieth century through Solow's two articles, "A Contribution to the Theory of Economic Growth" (1956) and "Technical Change and the Aggregate Production Function" (1957). With these articles the literature became an important area of study in macroeconomics. The foundation of a neoclassical growth framework started with the work of Robert Solow, who believed that economic growth was a result of capital accumulation. Later on, Romer (1986) and Lucas (1988) developed an endogenous growth model, which indicates that government policies can change some variables permanently and those changes would have a permanent impact on growth rate. The endogenous growth model was unlike what Solow demonstrated in his research; according to endogenous models, long-run growth depends on exogenous technological progress. Advocates of endogenous theories believe that economic growth is an endogenous outcome of an economic system.

In general, it can be concluded that there were three waves of concentration in growth frameworks during the last century. The first one was related to the work of Harrod (1948) and Domar (1947), and was an intermediate step between classical and neoclassical theory. The second wave introduced the neoclassical growth models (Ramsey 1928; Solow 1956; Swan 1956; Cass 1965; Koopmans 1965). The first two approaches (Solow and Swan) offer the first neoclassical framework of long-term growth and mark the start point for neoclassical theories that were built on it, such as the Mankiw, Romer and Weil model (1992). The third wave started as a response to deficiencies in the neoclassical framework and comprised what are known as "endogenous growth models" (Lucas 1988; Romer 1990).

A number of growth theories have been developed by economists over time to explain growth. These theories are mainly established in a production function approach in line with microeconomic theories where growth on an aggregate level is a factor of inputs and technology. Specifically, alterations in output are created by changes in physical capital, human capital and technology. Although some of these theories have been augmented by other factors, natural resources were never a part of the growth process.

The rest of this chapter is set out as follows: Section 2.2 starts reviewing the growth models by outlining the Harrod-Domar theory. This is followed by Section 2.3, which reviews the neoclassical model since it has been used as a guideline model in most studies on economic growth. In addition, this section investigates the most dominant neoclassical models besides the Solow model, such as the Ramsey-Cass-Koopmans model and the Overlapping Generations model, followed by the Stochastic Solow framework. Section 2.4 looks at some studies centred on augmentations of the Solow model. Then in Section 2.5, the focus moves on to analyses of endogenous growth frameworks, while the last section summarizes the key points from this chapter.

2.2 The Harrod-Domar Model

This review begins with the Harrod-Domar model which is an extension of Keynes analysis from a long period perspective. Economic growth and development are both dynamic routes; therefore, the first attempt to create a concrete growth model started with dynamic evaluation of economics. Modern growth models were born out of Keynes (1936) General Theory by expanding his analysis into the long term. Harrod (1939) and Domar (1946); (1947), using different routes, aimed to develop Keynes' analysis into a long-run and dynamic theory. Interestingly enough, they came to the same conclusion, which answered the following question: When can an economy experience a constant growth rate? The response from both was when the fraction of income saved is equal to the product of the capital outcome ratio and the rate of population growth. Domar considered how investment augments the capital stock directly by differentiating between the dependence of actual output on effective demand and the dependence of potential output on the capital stock (Hacche 1979). However, Harrod took this association into account through the acceleration principle, whereby manufacturers' demand for capital merchandises is related to output.

2.2.1 Harrod's model

Harrod's framework starts with an accounting identity based on Keynesian identity analysing the requirements for maintaining full employment in a long period. It is supposed that saving is a function of output and investment is determined by the acceleration principle where investment is a function of output.

$$G(t) \equiv \frac{\dot{Y}(t)}{Y(t)} = \frac{s}{v} \tag{2.1}$$

where v is the acceleration and s the propensity to save. Equation (2.1) is the essential equation of Harrod's model. According to him, this equation demonstrates the "dynamic theory constituting the marriage of the acceleration principle and the multiplier theory" (Harrod 1939: 16). Assuming the economy is in equilibrium, s and v are constant and positive, which indicates that there is a unique growth path for output, investment and saving. This satisfies Keynesian equilibrium conditions and demonstrates that along the growth path all three variables of output, investment and saving grow at the same rate of $\frac{s}{v}$. Harrod called this rate the "warranted growth rate". However, this is not automatically a full-employment equilibrium growth path since the labour market has not been considered.

It is assumed in the labour market that labour force (L) grows at an exogenous rate λ, and at the same time labour productivity grows at rate of τ. Therefore, two conditions for the permanent maintenance of full employment will be full employment at the beginning and growth of output at the rate of $\lambda + \tau$. Output should grow at an adequate rate to be able to absorb new workers. If the natural rate of growth, the rate that keeps the economy in full employment, is n, then according to Harrod, n should be $\lambda + \tau$, which is constant and exogenous. If the equilibrium growth path is stated as a growth path that is both natural and warranted, then in Harrod's framework there is a unique equilibrium. This equilibrium path has the conditions for steady-state growth, which is an essential notion in modern growth theories. However, it is unlikely that the economy will be on the equilibrium growth path.

2.2.2 Domar's Model

Domar adopted the same saving function as Harrod but instead of only investment he inserted an association between the rate of increase in full-employment output and investment. He expresses any units of investment or new capital raising output in σ units. In his model, saving is a function of output again. Equilibrium conditions are $I = S$ and $Y = \bar{Y}$. The model indicates for full-employment equilibrium that both income and investment should grow at a constant rate, which is σs[1].

The growth rate in Harrod's model $\frac{s}{v}$ is similar to the growth rate in that of Domar, σs. Domar exhibited potential growth through investment to highlight the importance of capital accumulation. He adopted the Keynesian multiplier and developed a framework in which investment plays a dual role. To keep the economy in full employment, investment needs to grow at a specific exogenous rate. Although he did not explain how investment is determined, his framework demonstrates what the path of investment should be.

Harrod and Domar theorized a concrete and linear connection between economic growth and investment. The two writers got almost the same results that in an unmanaged economy there is no tendency for a full-employment growth path. Most

[1] The solution will be $\frac{\dot{Y}}{Y} = \frac{\dot{I}}{I} = \sigma s$.

likely the significant dissimilarity between Harrod's and Domar's methods is the use of an accelerator and multiplier.

2.3 The Neoclassical Growth Model

Neoclassical growth theories can be traced back to Marshall (1898), Ramsey (1928), Solow (1956), Swan (1956), Cass (1965) and Koopmans (1965). It could be said that the neoclassical growth model started with the Solow framework and some more advanced expansions based upon it. Despite the fact that the neoclassical growth model is dated in the growth literature and research on economic growth has evolved over time, it is still one of the most important growth frameworks in economics. Solow and Tobin criticized deficiencies in the Harrod-Domar model in the same way. They believed it is an unlikely assumption to have fixed coefficients in the economy. The existence of variable coefficients in the real world is inevitable and it is naive to ignore this variety in the long-term. This was the first step towards a neoclassical analysis of economic growth. "An economy evolving according to the Harrod-Domar rules would be expected to alternate between long periods of intensifying labour shortage and long periods of unemployment" (Solow 1999: 641). In other words, according to Harrod and Domar, the economic growth rate of a country is equal to saving divided by the capital-output ratio. The problem in this model is that continual growth only happens accidentally and the chance of this happening is not very high. The real world is not that unstable; therefore, the key features of the Harrod-Domar theorizing did not match the empirical results of the process of economic growth. In addition, Solow indicated that the Harrod-Domar framework always analyses long-term problems with short-term gadgets (Solow 1956).

2.3.1 The Solow Model

The Solow growth framework is a fundamental reference for the majority of growth analysis. Given the history of the Solow model, it can be said that Solow's work is a major part of any economist's toolkit. It has been used in both discrete and continuous time (see (Obstfeld and Rogoff 1996; Romer and Chow 1996). Robert Solow (1956) developed a model to overcome some of the drawbacks in the Harrod-Domar model. In Solow's model, output is the only homogeneous commodity that is produced by two factors of production: capital (K) and labour (L). Factors of production can be operated in different propositions with constant returns to scale (henceforth CRS) and are paid according to their marginal products. This model assumes that the marginal product of both labour and capital is positive and returns to them are diminishing. Solow considered a production function for a final good in a standard neoclassical theory as follows:

$$Y(t) = F\big(K(t), L(t), A\,(t)\big) \tag{2.2}$$

where $Y(t)$ denotes the total output at time t, $K(t)$ is the capital stock, $L(t)$ is the labour force and $A\,(t)$ is the level of technology. Solow assumed that both labour and technology grow exogenously at the rate of n and g, respectively. Therefore, the effective units of labour grow at the rate of $g + n$.

$$L(t) = L(0)e^{nt} \tag{2.3}$$

$$A(t) = A(0)e^{gt} \tag{2.4}$$

The other factor of production, capital, is accumulated as a result of saving behaviour. Solow assumed that in a closed economy with a large number of identical households a constant fraction of disposal income s is saved and invested. Furthermore, the capital that is generated through investment depreciates at the constant rate of $\delta \in (0,1)$, which means that out of one unit of capital at time t, just $1 - \delta$ is left for the $t + 1$ period. Hence the essential law of motion of the capital stock is given by:

$$K(t+1) = (1-\delta)K(t) + I(t) \tag{2.5}$$

where I is investment at time t. According to Solow's saving assumption, investment will be defined as follows:

$$S(t) = sY(t) \qquad\qquad 0 < s < 1 \tag{2.6}$$
$$I(t) = S(t)$$

From national income accounting we have:

$$Y(t) = C(t) + I(t) \tag{2.7}$$
$$S(t) = I(t) = Y(t) - C(t) \tag{2.8}$$

From the above we will have:

$$C(t) = (1-s)Y(t) \tag{2.9}$$

Rewriting the fundamental law of motion in the Solow growth model will give us:

$$K(t+1) = sF\big(K(t),\ L(t)\,A(t)\big) + (1-\delta)K(t) \tag{2.10}$$

$$\dot{K}(t) = sF\big(K(t), A(t)L(t)\big) - \delta K(t) \tag{2.11}$$

Equation (2.11) is a non-linear difference equation that describes the equilibrium of the Solow model along with equations of motion for labour and technology.

The effective units of labour are expressed by $A(t)L(t)$; therefore, output per effective unit of labour, and capital per effective unit of labour, can be defined as:

$$y(t) = \frac{Y}{A(t)l(t)}$$

$$k(t) \equiv \frac{K(t)}{A(t)L(t)}$$

By considering a Cobb-Douglas production function we will have:

$$Y(t) = F\big(K(t), L(t), A(t)\big) = AK(t)^{\alpha} L(t)^{1-\alpha} \qquad 0 < \alpha < 1 \qquad (2.12)$$

Dividing the production function by $A(t)L(t)$, the production function per effective unit of labour becomes:

$$y(t) = k(t)^{\alpha} \qquad (2.13)$$

Dividing both sides of (2.10) by AL the evolution of the capital labour ratio will be:

$$k(t+1) = sf\big(k(t)\big) + (1-\delta)k(t) \qquad (2.14)$$

Steady-state equilibrium can be defined as an equilibrium path in which $k(t) = k^*$ for all periods of t. There is a unique steady-state equilibrium where:

$$y^* = f(k^*) \qquad (2.15)$$

And per capita consumption will be:

$$c^* = (1-s)f(k^*) \qquad (2.16)$$

By differentiating the effective capital-labour ratio with respect to time we will have:

$$\frac{\dot{k}(t)}{k(t)} = \frac{\dot{K}(t)}{K(t)} - \frac{\dot{A}(t)}{A(t)} - \frac{\dot{L}(t)}{L(t)} \qquad (2.17)$$

$$\frac{\dot{k}(t)}{k(t)} = \frac{\dot{K}(t)}{K(t)} - g - n \tag{2.18}$$

According to the assumption of constant returns to scale the quantity of output per effective labour will be:

$$\hat{y}(t) \equiv \frac{Y(t)}{A(t)L(t)} \tag{2.19}$$

$$= F\left(\frac{K(t)}{A(t)L(t)}, 1\right)$$

$$\equiv f\big(k(t)\big)$$

Since income per capita is $y(t) = {}^{Y(t)}\!/_{L(t)}$, then

$$y(t) = A(t)\hat{y}(t) \tag{2.20}$$

$$= A(t)f(k(t))$$

It is worth mentioning that if $\hat{y}(t)$ is constant, $y(t)$ income per capita will still grow since $A(t)$ grows over time. This indicates that growth models with technological improvement have a balanced growth path (BGP) rather than a steady-state path. Taking $\dot{K}(t)$ from equation (2.11) and putting into equation (2.18) we will have:

$$\frac{\dot{k}(t)}{k(t)} = \frac{sF(K(t),A(t)L(t))}{K(t)} - (\delta + g + n)$$

Using capital per unit of effective labour

$$\frac{\dot{k}(t)}{k(t)} = \frac{sf\big(k(t)\big)}{k(t)} - (\delta + g + n) \tag{2.21}$$

Rewriting equation (2.21) into the Cobb-Douglas production function will give us:

$$k^* = \left[{}^{s}/_{n + g + \delta}\right]^{1/_{1-\alpha}} \tag{2.22}$$

Rewriting equation (2.22) into the production function will give us log income per capita at any instant in time.

$$\ln\left(\frac{Y}{L}\right) = \alpha + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln(n + g + \delta) \tag{2.23}$$

Figure (2.1) demonstrates the terms of the investment equation, break-even investment and a steady-state path in the Solow model. The element $(\delta + n)k$ corresponds to the break-even investment. In other words, this is the amount of investment that requires constant capital per worker to be maintained. In a steady-state path, all variables grow equally and there would be just one probable growth rate for the capital-labour ratio, which is zero, and k is constant in a steady state. The figure illustrates that there is only one stock of capital (k^*) where investment is equal to the break-even investment. When the economy is performing at this level of capital stock, the capital stock will stay constant due to the two forces acting on it. It can be said that at $k^*, \Delta k = 0$ both the stock of physical capital and output per worker will be steady over time. For this reason k^* is called "steady-state level of capital per worker".

Assuming that labour grows at the rate of n, capital grows at the same rate, and due to constant returns to scale, output should also grow at the same rate. If labour grows at the rate of n, the economy in the long run will reach a state of growth where investment, physical capital and output all grow at the same rate. This means the equilibrium in this model is stable when eventually the economy converges to its balanced growth path. Therefore, irrespective of the level of capital at the start point, it always ends up with a steady-state level of capital. For instance, if the economy begins with less than the steady-state level of capital (left-hand side of k^*), then the level of investment exceeds the break-even investment for that level of capital. In the long-term the capital increases and will continue to increase until it gets to the point of steady-state k^*. Likewise, when the economy begins with more than the steady-state level of capital (right-hand side of k^*), investment is less than what is necessary to keep constant capital per worker. Thus, the capital per worker will decrease to reach the steady-state level. Once capital per worker gets to the steady-state point, investment is equal to the break-even investment, and capital per worker does not need to decrease or increase. In other words, if $sAk^{\alpha} > (\delta + n)k$ then the stock of capital needs to increase, but if $k^{\alpha} < (\delta + n + g)k$, k needs to decrease. Therefore, the steady-state point is the point where k^* and Δk are equal to zero. At this point (break-even investment) all variables grow at the same constant rate.

Figure (2.1) demonstrates that there is only one stock of capital k^* where the amount of investment meets break-even investment and there is a balance in the economy. It can be said that at k^*, capital stock would not change ($\Delta k = 0$). Consequently, output per se and stock of capital will be steady over time. According to the assumption of constant returns to scale, when L grows at the rate of n, k should grow at the same rate, and additionally Y grows at the same rate. It can be concluded that the equilibrium in the Solow model is stable. In other words, when labour grows at the rate of n and technology grows at the rate of g, investment will grow at the rate of $n + g$, and so does the aggregate capital stock. Therefore, no matter what level of capital the economy starts with, it ends up at the steady-state point. In accordance with the diminishing returns to scale, the Solow model anticipates that any economy converges to its own steady-state point.

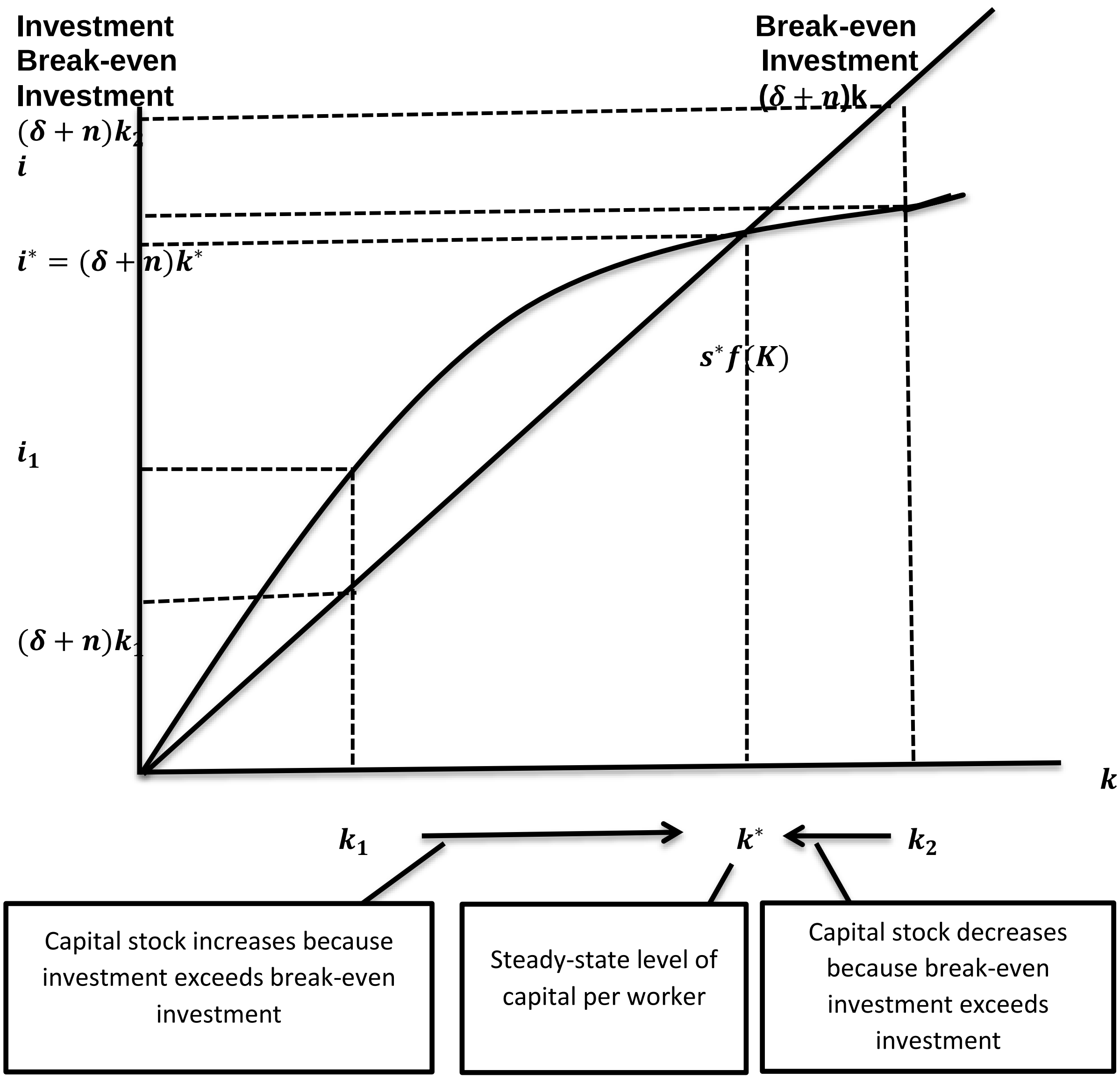


Figure (2.1) Steady-state Equilibrium with Population Growth and Technological Progress.

Source: Adapted from Mankiw (2000: 83)

As stated by Okada (1999), there are two reasons for convergence: technological circulation and diminishing returns to capital. There are different concepts of convergence in growth literature. In general, two versions of convergence are absolute and conditional convergence. In absolute convergence a group of countries have the same technology, exactly the same population growth and also the same savings rate. The only difference among them is the initial capital labour ratio. All countries will converge to the same steady-state capital labour ratio and output per capita, and definitely the same economic growth rate. Conditional convergence considers a group of countries that have access to the same technology and have the same population growth but do not have the same initial capital labour ratio and saving rates, yet they will converge to the same growth rate, although it could be at a different capital labour ratio. The notion of convergence in the Solow model forecasts two scenarios according to the steady-state point.

The first one is that if two countries have exactly the same rate of investment but do not have the same levels of income, the country with the lower income will grow faster than the country with the higher income. The second one is that if two countries have the same level of income but the rate of investment is different, the country with the higher rate of investment will grow faster. It is also important to mention that these predictions are only true when there are no other differences in the countries. Romer (1994) criticized convergence by indicating that if the same technology were available in all countries, human capital would not move between countries.

Conventionally, technological progress will improve the efficiency of labour and it grows at the same constant rate of g each year. This form of progress in technology has been called “labour augmenting”. If the assumption that labour grows at the rate of n is correct, the number of effective workers will grow at the rate of $n + g$. The law of motion for capital is:

$$\dot{k} = sAk^{\alpha} - (\delta + n + g)k \tag{2.24}$$

The Solow model indicates that the long-run growth rate is controlled by the rate of technological progress, which is not determined in the model. In other words, the Solow model considers the exogenous rate g to be the driver of economic growth. Solow investigated the U.S. economic data over the period 1909-1949 and tried to answer the question: What does the data say about economic growth? He concluded that seven-eighths of the economic growth in the United States is due to technological growth (Sachs and McArthur 2002). His empirical assessment was in line with his theoretical suggestion about the role of technology in the United States.

By including exhaustible resources in the Solow growth framework, surprisingly, the results remained mostly unchanged. Adding natural resources to the Solow growth model presents new dynamics and develops the possibility of substitutions in economic growth. In the production function with constant returns, capital and labour were considered the sole factor of production. The characteristic and powerful conclusion of the Solow model is that with technological development economic growth is exogenous since the long-run growth rate is not influenced by policies. In Solow's terms, the critical question of why most countries in reality display an increment in their living standard over time boils down to an exogenous technology improvement. It is necessary to mention that Solow (1986) and Hartwick (1977) illustrated necessary conditions under which an economy dependent on natural resources can have sustainable economies. The Solow-Hartwick rule needs non-declining wealth, which can be achieved by reinvesting all the income from natural resources in other forms of capital.

2.3.2 The Standard Ramsey-Cass-Koopmans Model

Cass (1965) and Koopmans (1965) presented a growth model with an endogenous saving rate by including Ramsey's (1928) optimization analysis. According to their model, saving and consumption are decided by households who are infinitely lived. They considered a closed economy where households want to maximize their utility. It is assumed that only one type of good is produced in the economy and the production function has constant returns to scale. In line with the Solow model, technology grows exogenously at the rate of g. Factors of production are paid according to their marginal product. In terms of population growth, it is assumed that a large number of identical households grow at the rate of n. Since both capital and labour are owned by households, in each period one unit of labour is supplied and one unit of capital is rented to firms. Individuals' revenue is divided between saving and consumption to maximize utility subject to a budget constraint. Depending on the budget constraint, the current value of consumption should not be higher than the sum of wealth and current value of income.

In line with the assumption of a closed economy, any variation in capital in the firms is a result of household savings, which, in terms of effective units, can be depicted as:

$$\dot{k}(t) = f\big(k(t)\big) - c(t) - (n + g + \delta)k(t) \tag{2.25}$$

Households maximize their utility subject to the budget constraint they have. Applying Lagrange, taking logarithms and differentiating with respect to time and substituting the rent of capital (marginal product), the consumption function can be obtained. Considering a Cobb-Douglas production function, and assuming that saving is given by $s = {}^{y-c}/_{y}$, a system of differential equations in y and s can be expressed. The steady-state values of y and s are:

$$y^* = \left(\frac{\alpha}{\Phi}\right)^{\frac{\alpha}{1-\alpha}} \tag{2.26}$$

$$s^* = \frac{\alpha\Gamma}{\Phi} \tag{2.27}$$

In the above model, y is predetermined and s is a jump variable. When the economy gets to the steady-state point, its performance is similar to that of the Solow model on the balanced-growth path. Capital, output, saving and consumption are constant. In line with the Solow model, all per capita variables grow at the rate of $n + g$.

2.3.3 The Standard Overlapping Generations Model

The previous section explained the RCK model with a representative household that lives forever and wants to maximize their utility. In this section, the Overlapping Generation (OG) framework will be discussed. The key difference between RCK and OG is that households will not live forever, as people are born, and old people die. The framework was introduced by Samuelson (1958) and Diamond (1965). The following OG framework is a relatively simple one based on Romer and Chow (1996). In contrast to the RCK framework, time is discrete in order to have more straightforward derivations. There are two different periods in each individual's life: in the first one people work and save, whereas in the second one people do not work and use their savings for living costs. Considering a Cobb-Douglas production function,

$$Y_t = K_t^{\alpha}(A_t L_t)^{(1-\alpha)} \qquad 0 < \alpha < 1 \tag{2.28}$$

where Y_t is output at time t, K is physical capital stock, A is the level of technology and L is labour.

The assumption of perfect competition for domestic markets is held and capital depreciates at a constant rate of δ. Rent of capital is the interest rate plus the rate of depreciation and labour receives wages according to the marginal product of capital.

The utility function of a person while still working is considered as:

$$U_t = \ln(\tilde{c}_t^Y) + \beta \ln(\tilde{c}_{t+1}^O) \tag{2.29}$$

where $\tilde{c}_t^Y$ depicts per capita consumption of a given person while working at time t, whereas $\tilde{c}_t^O$ depicts consumption of the same one when she is old and not working at time $t+1$ and β is the discount rate. It is important to mention that the logarithm form of the above utility function is a specific case of constant relative risk aversion utility, which is $U = {C^{1-\theta}}/{(1-\theta)}$, where the parameter θ is one. The budget constraint of individuals in different periods of time varies. The combined budget constraint indicates that the current value of a working individual's consumption is equal to the current value of her income. Therefore, a working person maximizes her utility function subject to the combined budget constraint. In order to simplify the analytical derivation of the model, it is considered that the depreciation rate is equal to one.

Accordingly, a working person's consumption is a fraction of output, which is constant. As a result, saving is independent of the interest rate while the person is working. As mentioned earlier, the logarithmic utility is unique when parameter θ is equal to 1. In other words, consumption is not a function of the interest rate unless $\theta \neq 1$.

In order to get the dynamics of the economy, the behaviour of individuals should be aggregated. The equation of motion for stock of physical capital can be rewritten as follows with some manipulation:

$$k_{t+1} = \frac{\beta(1-\alpha)}{(1+\beta)(1+n)(1+g)} k_t^{\alpha}. \tag{2.30}$$

Hence, the steady-state level of capital per worker will be:

$$k^* = \left(\frac{\beta(1-\alpha)}{(1+\beta)(1+n)(1+g)}\right)^{\frac{1}{1-\alpha}} \tag{2.31}$$

which can be expressed as a Cobb-Douglas as:

$$k^* = \left(\frac{\alpha}{(1+r)}\right)^{\frac{1}{1-\alpha}} \tag{2.31}$$

where r depicts interest rate in the equilibrium. According to k^*, no matter what the start point the economy always ends up at its steady-state level. The effective output in a steady state is:

$$y^* = \left(\frac{\beta(1-\alpha)}{(1+\beta)(1+n)(1+g)}\right)^{\frac{\alpha}{1-\alpha}}. \tag{2.32}$$

Therefore, the outcome indicates in a steady state that variables are growing at the same rate of growth, which is technology plus population growth. Thus, once the economy is on the balanced-growth path, this model is in line with the Solow model with respect to its steady state.

2.3.4 The Stochastic Solow Model

Binder and Pesaran (1999) developed a Solow-Swan growth model; however, in their model technology and labour are considered to be stochastic processes. They state in their paper that using the stochastic framework addresses a number of drawbacks of the deterministic models and gives a better explanation of the growth process. We assume an economy where the aggregate production function is explained by a constant return to scale as follows:

$$Y_t = f(A_t K_t H_t L_t) \tag{2.33}$$

where Y_t depicts real output, K_t physical capital stock, H_t human capital, L_t labour input and A_t the level of technology. It is assumed that $f(.)$ is twice continuously differentiable. In addition, it is also assumed that the country has specific initial endowments of technology and labour, which are exogenous.

The law of motion for physical capital is as follows and it depreciates at the constant rate of δ:

$$K_{t+1} = (1 - \delta_k)K_t + I_{kt}. \tag{2.34}$$

Similarly, the law of motion for human capital with a constant rate of depreciation will be:

$$H_{t+1} = (1 - \delta_H)H_t + I_{Ht}. \tag{2.35}$$

Aggregate saving is given by:

$$S_t = s(A_t K_t H_t L_t)Y_t. \tag{2.36}$$

In addition, there is one restriction in the saving function, which is $S_t/_{Y_t} \in (0,1)$, and in the equilibrium we have:

$$S_t = I_{Kt} + I_{Ht}. \qquad (2.37)$$

Applying the stochastic maximum principle and depicting the Lagrangian multiplier by λ_t gives us the first-order condition. If we assume both physical and human capital are depreciated at the same rate $\delta_K = \delta_H = \delta$, then at the optimum we have $\frac{\partial f_t}{\partial K_t} = \frac{\partial f_t}{\partial H_t}$.

Considering a Cobb-Douglas production function we will have

$$Y_t = A_t^{1-\gamma-\phi} K_t^{\gamma} H_t^{\phi} L_t^{1-\gamma-\phi}. \qquad (2.38)$$

We can write

$$H_t = \frac{\phi}{\gamma} K_t$$

and we can rewrite (2.38)

$$Y_t = A_t^{1-\alpha} K_t^{\alpha} L_t^{1-\alpha} \qquad (2.39)$$

where $\alpha = \phi + \gamma$, and α depicts the combined share of both physical and human capital. For the sake of simplicity it is assumed that saving function $s(k_t)$ from now on will be $s(k_t)Y_t$, which illustrates the portion of households' aggregate saving in period t that is invested in physical capital. Therefore, for the capital accumulation function we can write

$$k_{t+1} = (1-\delta)K_t + s(k_t)Y_t. \qquad (2.40)$$

It is also assumed Inada conditions are satisfied and f is twice continuously differentiable.

As a result, the stochastic difference equation depicting the capital accumulation from the effective capital labour ratio is:

$$k_{t+1} = \exp(-\tau - \Delta u_{t+1})[s(k_t)f(k_t) + (1-\delta)k_t] \qquad (2.41)$$

where $\tau = n + g$ and $\Delta u_{t+1} = -(1-\rho_a)u_{at} - (1-\rho_l)u_{lt} + \varepsilon_{t+1}$.

It is important to mention that $u_t = u_{at} + u_{lt}$.

Binder and Pesaran (1999) have distinguished between cases where technology and population growth have a unit root and where they are stationary.

I) Stochastic Solow with Unit Root in Technology and Population Growth

In a case with technology and population growth with a unit root the law of motion will be:

$$k_{t+1} = \exp(-\tau - \varepsilon_{t+1})\,[s(k_t)f(k_t) + (1-\delta)k_t] \qquad (2.42)$$

Binder and Pesaran (1999) in three steps established conditions under which $\{k_t\}$ could be ergodic. They indicated that with probability one $\{k_t\}$ does not get absorbed by the condition of k_0. Then under some other conditions with probability one again $\{logk_t\}$ is not dependent on the initial conditions $logk_0$. At the end they demonstrated whether $logk_\infty$ and k_∞ had finite moments up to order r. As a result, $\{k_t\}$ is ergodic.

II) Stochastic Solow Model with Stationary Technology and Population Growth

Binder and Pesaran (1999) indicated that this one is more complicated since $\{k_t\}$ depends on the primary value of the stock. They showed that for any finite initial conditions k_o and u_o , $\{k_o\}$ with probability one does not get absorbed by the bounds of zero or positive infinity if the conditions mentioned in the appendix are satisfied, and also if the truncation condition, which is

$$F_{\varsigma}[\log(1-\delta)-n-g]=0, \qquad (2.43)$$

is satisfied, where $F_{\varsigma}(.)$, as indicated in Binder and Pesaran (1999), is the limiting cumulative distribution function of the composite shocks

$$\varsigma_{t+1}(\rho_a,\rho_l)=-(1-\rho_a)u_{at}-(1-\rho_l)u_{lt}+\varepsilon_{t+1} \qquad (2.44)$$

Subsequently, under a specific assumption they show that asymptotically $\{logk_l\}$ probability one does not depend on the initial condition k_0. Hence, $\{logk_l\}$ converges to the steady-state probability distribution function.

2.4 The Augmented Solow Model

Mankiw et al. (1992) augmented the Solow model by including a proxy for human capital accumulation. They illustrated that income per capita not only depends on population growth and accumulation of physical capital but also on the accumulation of human capital. They claimed that not taking into account the human capital accumulation is the reason for biased coefficients on saving and population growth. They tested data for 121 countries over the period 1960-1985 to see if they support Solow's growth framework. They assumed that technological progress g and the rate of depreciation δ are constant across countries. The results indicated a larger impact of saving and population growth than the Solow model prediction. They tested the same data after adding human capital accumulation. Their outcome demonstrated that leaving out human capital influences coefficients on physical capital, investment and labour force growth.

The MRW model was denoted as:

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} (A(t)L(t))^{1-\alpha-\beta} \tag{2.45}$$

where all variables are defined like the Solow model but H is added as a stock of human capital. They differentiated between the rate of saving in human capital s_h and the saving rate in physical capital s_k, and defined the law of motion for physical and human capital as follows on the assumption that human capital depreciates at the same rate as physical capital:

$$\dot{k}(t) = s_k y(t) - (n + g + \delta)k(t) \tag{2.46}$$

$$\dot{h}(t) = s_h y(t) - (n + g + \delta)h(t) \tag{2.47}$$

MRW's model concluded that the economy converges to the steady state as defined by:

$$k^* = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{n+g+\delta}\right)^{1/(1-\alpha-\beta)} \tag{2.48}$$

$$h^* = \left(\frac{s_k^{\alpha} s_h^{1-\alpha}}{n+g+\delta}\right)^{1/(1-\alpha-\beta)} \tag{2.49}$$

Substituting (2.48) and (2.49) into the production function and taking logs gives the following equation, which demonstrates how income per capita depends on population growth and accumulation of both physical and human capital.

$$ln\left[\frac{Y(t)}{L(t)}\right] = lnA(0) + gt - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n + g + \delta) + \frac{\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\beta}{1-\alpha-\beta}\ln(s_k) \tag{2.50}$$

Although MRW'S model was in line with the empirical studies, it was criticized by several authors for assuming an equal technological progress rate across all countries (Grossman and Helpman 1993; Temple 1998b).

Nonneman and Vanhoudt (1996) suggested a further augmentation of the Solow framework by adding the endogenous accumulation of technological know-how. Following MRW, they chose a Cobb-Douglas production function as well; however, technology was assumed as a form of capital just like any other factors of production in the neoclassical model. In other words, they extended MRW's model by assuming there are no externalities, like spillovers or increasing returns from technology. Since their model has three types of capital, which all depreciate at the rate of δ, the logarithm of per capita income will be:

$$\begin{aligned}\ln(y) = \alpha_0 + \frac{\alpha_k}{1-(\alpha_k+\alpha_h+\alpha_T)} ln(s_k) \\ + \frac{\alpha_h}{1-(\alpha_k+\alpha_h+\alpha_T)} \ln(s_h) + \frac{\alpha_T}{1-(\alpha_k+\alpha_h+\alpha_T)} \ln(s_T) \\ - \frac{\alpha_k+\alpha_h+\alpha_T}{1-(\alpha_k+\alpha_h+\alpha_T)} \ln(n+\delta) \qquad (2.51)\end{aligned}$$

The empirical part of their study used data from Barro and Lee (1994) except for investment in research and development (henceforth R&D) for OECD countries. The augmented Solow model in the study explains almost three-quarters of the variation in per capita income. However, the model explains up to 80 per cent of variations in growth by relaxing the assumption that economies are close to a steady state. In contrast to the MRW model, human capital is not significant in explaining the variation in growth rate. The statistically important variables are investment in physical capital, technological know-how and the condition of economy at the start point. Nevertheless, their study was criticized by different scholars such as Temple (1998b), who concluded that the reason the coefficient on R&D is not significant is because at any conventional level heteroscedasticity is allowed.

In another line of research, Long and Summers (1991) argued that there is a significant relationship between equipment investment and economic growth. Temple (1998a) investigated the correlation between equipment investment and economic growth and its compatibility with the MRW model. He included the stock of equipment as an input in a Cobb-Douglas production function. In other words, he disaggregates capital stock into equipment and structure. He believes disaggregation improves the performance of the MRW growth model. The paper finds some econometric difficulties in estimating the model, such as: i) endogeneity, ii) outliers, iii) simultaneity and iv) heterogeneity.

Using the same model, Jalilian and Odedokun (2000) go one step further by developing the range of categories of investment utilized in the growth literature, breaking down the investment ratio into different categories: business investment to GDP, machinery equipment investment to GDP, transport investment to GDP, residential investment to GDP and other durable private investment to GDP ratios. For the empirical investment they used panel data through the fixed-effect technique. They studied 55 countries over the period 1965-1990 and a five-year period was chosen as a unit of time to avoid the impact of the business cycle. The outcome shows that human capital investment, the machinery equipment investment to GDP ratio and unspecified investment to GDP ratio are statistically significant in terms of economic growth.

Cavalcanti et al. (2011b) developed a standard growth model including natural resources as an input in the production function. In their model the rental price of natural resources is determined according to its marginal productivity. They assumed there are identical infinitely lived households in the economy and present the economy through a representative household that wants to maximize its utility. To do so, the representative household needs to decide on the path of consumption, resource extraction rate, investment in natural resources and stock of both physical capital and natural resources. Their theoretical model proposed a long-term association amongst per capita income, the investment rate and the real value of natural resources production per capita. They tested their theory empirically by estimating a panel error correction model, which indicates that oil abundance has a significantly positive impact on growth in both the short and long-term.

It can be concluded that neoclassical theories in general assume a diminishing return to each input, which is translated into a smooth elasticity of substitutions amongst inputs. According to the neoclassical theories, economic growth is the outcome of technological progress and capital accumulation. Assuming a constant technological improvement and a steady growth in labour means per capita production depends on capital accumulation. Therefore, the law of diminishing marginal returns creates less output by increasing capital stock. Thus, in the long term, increases in output per capita can only be maintained by progress in productivity.

2.5 Endogenous Growth Models

By the late 1960s, there was not much interest in theoretical growth; however, in the 1980s the interest was revived again by the work of Romer (1986) and Lucas (1988)

Despite its role as the foundation of the modern economic growth framework, the Solow model is absolutely silent on some of its assumptions. One purpose of growth theory is to clarify the continuing rise in living standards in some parts of the world. In general, the engine of growth as described in Solow's work was the assumption of exogenous technological progress. However, the model did not explain where this technological improvement comes from. According to the Solow framework, if technological progress does not occur in the economy, then the effects of diminishing returns will eventually cease economic growth. In addition, it was assumed that the level of technology is the same all around the world.

In the Solow model, the principal variable beside capital accumulation is "labour productivity" (A), whose exact meaning is not clear and it is assumed that labour productivity (A) grows constantly and exogenously. In response, the capital stock is constantly increasing, enabling a continual increase in the level of output and consumption. The literature on endogenous growth focuses on explaining (A) and replaces exogenous productivity with endogenous process. The effectiveness of labour is translated into knowledge and technology. This variable has increasing returns to scale in contrast to the Solow model. In addition, until 20 years ago the differences in the economic growth rate in different countries were not explained by neoclassical growth theories such as that of Solow. The Solow model does not give any reasons why population growth n and rate of saving s are different across countries. This gap in the literature of economic growth caused economists to think of a new growth framework. The endogenous model came into existence through the work of Romer (1986) and Lucas (1988), who rejected the assumption of exogenous technological progress (Mankiw 2007).

A new strand of research was born arguing that technological progress rests on decisions that come from improvements and innovations made by profit-seeking businesses and depends on knowledge and human capital accumulation. Synthesizing endogenous technology into the growth paradigm brings the phenomenon of increasing returns to scale. Therefore, to improve the existing technology, the labour force needs motivation. On the other hand, according to the aggregate production function, capital and labour should be paid their marginal products, which means leaving nothing to pay for enhancement in technology, meaning endogenous growth theories cannot rely on competitive equilibrium. Arrow (1962) suggestion for solving this issue was the idea of considering technological progress to be a consequence of producing new capital, which was labelled “learning by doing”.

2.5.1 The AK Model

The AK model started with the work of Harrod (1939) and Domar (1946), who proposed an aggregate production function with fixed coefficients. The first AK model with interchangeable factors of production and knowledge externalities was introduced by Frankel (1962) in order to join the results of the Harrod-Domar model to the features of a neoclassical model. Romer (1986) developed the AK model with intertemporal consumer maximization, which is in contrast to the Solow and Frankel models. Arrow (1962) argues that productivity can increase by gaining experience, which can accumulate knowledge and introduces learning by doing externalities in the AK model. Lucas (1998) argues that human capital accumulation is a means to create and transmit knowledge. Rebelo (1991) explains, through the AK models, how heterogeneity in growth rate can be the effect of cross-country dissimilarities in policies. Jones et al. (1999) used the AK model to investigate the impact of macroeconomic volatility on economic growth. Acemoglu and Ventura (2002) used the AK model to evaluate the influence of trade on growth.

The simplest endogenous growth model is known as the AK style growth model, introduced by Rebelo (1991), in contrast to the Solow model with linear production technology in capital. However, what matters most is the linearity of the accumulation technology not the linearity of the production technology. It is assumed that the population growth rate, saving rate and depreciation are all constant.

$$Y(t) = AK(t) \qquad\qquad A > 0$$

where A is the level of technology and is constant. Here production depends only on the reproducible factor with no diminishing returns to scale.

All other equations are the same as in the Solow model. Therefore, the law of motion for the capital labour ratio will be:

$$\dot{k}(t) = sAk(t) - (n + \delta)k(t) \tag{2.51}$$

Therefore, if $sA > (n + \delta)$, the economy's income grows forever, at a constant growth rate, without the assumption of exogenous technological improvements. Dividing (2.51) by k denotes the growth rate of capital per worker in the economy, which is equal to the growth rate of per capita income.

$$\frac{\dot{k}}{k} = sA - (n + \delta) \tag{2.52}$$

$$\gamma = sA - (n + \delta) \tag{2.53}$$

Equation (2.53) illustrates that the growth rate of per capita income increases with the rise of A and s, and decreases with the depreciation of n and δ.

The Ak model has been criticized for the assumption of no diminishing returns to scale, which plays an important role in economic thinking. Nevertheless, the abandonment of diminishing returns to capital depends on how the variable K is interpreted in the production function. If capital is considered in the traditional view, which includes only stock of plants and equipment, diminishing returns is a necessary assumption. Nevertheless, advocates of an endogenous model believe that if capital is considered in a broad way, constant returns to capital is more acceptable.

2.5.2 The Frankel-Romer Model with Full Employment

Another version of the AK model considers technological knowledge to be a capital good. Technological knowledge can be either used in combination with other production factors for final production or it can be stored and accumulated through R&D and other knowledge creation activities. In this model, knowledge is a capital good since capital is an aggregate of different sorts of capital goods in its broad meaning. Frankel (1962) assumed all firms have the same technology and the same factor prices; therefore, factors will be employed in the same ratios and thus aggregate output is written as:

$$Y = \bar{A}K^{\alpha}L^{1-\alpha} \tag{2.54}$$

In addition, he assumed $\bar{A}$ is a function of the capital labour ratio.

$$\bar{A} = A\left(K/_{L}\right)^{\beta} \tag{2.55}$$

It was assumed that even though $\bar{A}$ is endogenous, it is taken as given by business, since a business would just adopt the effects of its own investment decisions. Frankel gave attention to a case where $\alpha + \beta = 1$, and stated in this case that (2.54) and (2.55) $Y = AK$. When capital rises, output rises in proportion, although there is persistent full employment and substitutability in the aggregate production function since knowledge inevitably surges in proportion. The difference from Harrod-Domar is that an increase in the saving rate would raise the growth rate constantly.

2.5.3 An AK model with Utility Maximization

Romer (1986) developed a Ramsey model in which the rate of saving is intertemporal utility maximization by a representative household. His contribution with the influential work of Lucas (1988) became a benchmark for the recent literature on endogenous models. He assumed a production function with externalities and concentrates on the situation in which the supply of labour per business is equal to unity and there is no capital depreciation. In Romer's model, the saving rate is decided by the representative household and it is assumed there is one worker business with the dynamic optimization problem of:

$$max \int_0^\infty u\,(c_t)\, e^{-\rho t} dt \quad \text{subject to } \dot{k} = \bar{A}k^\alpha - c \qquad (2.56)$$

where k is the capital stock of the individual business, $y = \bar{A}k^\alpha$ is output, $c = c_t$ is the current consumption and $\bar{A}$ represents aggregate productivity, which is taken as given by each business. In Romer's model, aggregate productivity depends on the stock of capital and assumes constant intertemporal elasticity of substitution.

Applying the Euler condition, the outcome will be according to rational expectations; individuals predict that the same level of capital will be chosen at each instant of time by all businesses. The Euler condition can be written as follows:

$$-\varepsilon \, {}^{\dot{c}}/_{c} = \rho - \alpha A K^{\alpha+\beta-1} \tag{2.57}$$

There are three cases to investigate based on the exponent $\alpha + \beta$.

If $\alpha + \beta = 1$ means that there are constant social returns to capital, the economy maintains positive but finite growth rate of g. In this case, diminishing returns to capital are compensated by external enhancement in the technology $\bar{A}$. In other words, in a steady state, output and consumption will both grow at the same rate, so this case implies:

$$g = \frac{\alpha A - \rho}{\varepsilon} \tag{2.58}$$

Romer assumed that $\alpha + \beta > 1$ means increasing social returns to capital; in this case, growth will accelerate indeterminately. In the case of decreasing returns to scale, growth will cease asymptotically as in the neoclassical model with exogenous technology progress.

If $\alpha + \beta < 1$, which means there are decreasing returns to capital, growth will vanish asymptotically as in the neoclassical model without technological improvement.

In a nutshell, the key outcome from this endogenous growth framework is that with a constant social returns to capital, characteristics of the economy like discount rate or the size of the economy will impact on the long-term growth. Although growth has been explained as an endogenous process, it relies utterly on external accumulation of knowledge.

2.5.4 Some other Endogenous Models

Arrow (1962) introduced an endogenous theory on the alteration in knowledge, which stresses changes in production function. He argued that learning is the product of experience. He hypothesized that technical change can be ascribed to experience. He also stated that learning and experience can be captured in investment since any new machine has the ability to improve the current production. In his model he introduced cumulative gross investment as an index that can represent experience. Then he developed the same framework as Johansen (1959), where technological progress encompasses new capital. Shell (1967) looked at the process of knowledge acquisition from a different perspective to Arrow (1962), but unlike Arrow, he believes knowledge is produced intentionally by curious researchers.

Lucas (1998) gave attention to the role of human capital in the growth model in the long run. In his model, previously accumulated human capital is the sole input for new human capital. He also mentioned that physical and human capital are both produced differently by different technologies; in his model, a fraction of time is used for working and the rest is used for studying.

In another series of endogenous models externality was introduced in human capital, which mirrors human capital accumulation and raises the productivity of other factors of production. Nonetheless, Sala-i-Martin (1990) showed that this externality is not necessary for endogenous models. In this model, both physical and human capitals have constant returns to scale. In addition, generating new human capital also has constant returns to scale. In summary, generating human capital is the driver of growth in the long run in endogenous models.

Although the endogenous frameworks presented a good description of long-term growth, they suffered from a lack of theory on technological progress. To address this problem, Romer (1990), Lucas (1988), Grossman and Helpman (1991b) and Aghion and Howitt (1992) introduced a new economic growth framework that embraces development and investment in R&D. In these models, innovation in industry is considered to be the driver of growth. They highlight the importance of R&D for economic growth. In the same line of research, Romer (1990) developed a new model where the main source of growth is technology improvement, which is similar to the Solow framework with labour-augmented technology but in this model technology (A) emerges from investment by agents and entrepreneurs with the incentive of maximizing profit. In his model, resources are devoted to R&D and the model is built on microeconomic bases. The driver of growth in Romer's framework is R&D, which motivates firms to allocate resources.

In any framework where building knowledge is driven by profit, the assumption of perfect competition must be ignored. If the owner of knowledge wants to sell it at marginal cost, the returns will be negative. Romer handles this problem by supposing that the creator of knowledge has monopoly rights to use it. He also assumes that knowledge encompasses different ideas that feed into (inputs into) production. In regard to these assumptions, the owner of a new idea can ask for a higher price than marginal cost. Non-zero profit can be a motivation for R&D. It is imagined that there are a variety of ideas from 0 to A. The four essential inputs of this model are physical capital, human capital, labour and an index that exhibits the level of the technology.

The accumulation of new capital is given by:

$$\dot{K} = Y - C \tag{2.59}$$

To be specific, the accumulation of new designs (knowledge) should go according to the growth rate of $A(t)$. Research output depends on both the amount of human capital dedicated to research and the stock of available knowledge. Summing up across all researchers, the aggregate stock of knowledge grows according to the equation

$$\dot{A} = \phi H_A A \tag{2.60}$$

where ϕ is a productivity parameter, H_A is the human capital work in the research sector and A is the total stock of knowledge. It is supposed that any firm involved in research has access to the total stock of knowledge. In other words, knowledge production has external impacts that come from knowledge spillover, as a novel design on the productivity of human capital in the entire research sector. Other firms can use the benefit from the research sector to produce capital and final output. However, any innovation on capital goods can be monopolized by firms and thus they can sell their novelty.

The difference between (A) in Lucas (1998) and equation (2.60) is that in the former, the stock of knowledge has an indirect effect since a new design will lead to the generation of new capital, which can be used to create output. However, in the latter, the research sector has a direct impact on output. What makes unlimited growth is linearity in (A), as Romer said "unbounded growth is more like an assumption than a result" (1990: 84). The other distinctive feature of this framework for creating endogenous growth is that the final output technology makes the long-term growth possible by generating different numbers of producer goods.

Another strand of research was introduced by Grossman and Helpman (1991a:chapter 3), where in an endogenous growth model, intentional investment in R&D has a significant role. The difference in their model from Romer's (1990) is that growth is the product of generating different consumer goods, which is likely to happen through intentional accumulation of knowledge. Entities expand the range of available products through involvement in research. Firms will hold a monopoly on any new product, which means that firms are entitled to any profit that arises from that product.

Nevertheless, some recent researchers have stressed the significant role of non-technological sources of differences in total factor productivity. For instance, Solow (2001) claims that the non-technological sources of differences in total factor productivity may have a more significant role than the technological factors mainly in developing countries. In line with this argument, there are some studies that concentrate on the importance of institutions on economic growth (Acemoglu et al. 2001b; McArthur and Sachs 2001; Esfahani and Ramírez 2003). One essential factor for economic growth is capital, and not only physical and human capital but also all kinds of capital. "All models of growth, after all, stress the necessity and the power of capital" (Landes 1998: 171). By reviewing different growth models it can be concluded that there is a consensus that economic growth is impossible without capital.

Aghion and Howitt (1992) developed an endogenous stochastic framework built on Schumpeter's[1] process of creative destruction. It is distinct from the previous endogenous models in that it stresses the obsolescence of the old technologies derived from the accumulation of knowledge or innovation. In other words, it believes technological progress does not always create gains, but can create losses as well. In their framework a creator gets a patent for each and every newly created good. Then the creator can sell each patent to an entrepreneur who becomes a monopolist for those goods until the next innovation. Thus, monopolistic rents are just temporary as in Romer's (1990) model. Nevertheless, there are two distortions in their model that act in opposite ways. The first is knowledge spillover and the second is business stealing impact or creative destruction.

A two-sector model of endogenous growth with human and physical capital was provided as an explanation of the different economic development experiences in different countries. To analyse a two-sector endogenous growth model, two sectors are considered: goods and education. Each sector in the model produces one type of capital under conditions of constant returns to scale and perfect competition. Jones (1965) indicates how these assumptions could translate to what is called "magnification effects". He indicates that a rise in the price of one sector's output will cause a greater than proportional rise in the price of the factor that has been used in that sector. For instance, assuming the education sector is labour-intensive, a rise in the price of human capital increases the wage rate, and as a result the profit on

[1] In the Schumpeterian model, growth is created by a random sequence of quality-improving innovations. The model portrays innovation as an essential aspect of industrial competition.

human capital will decrease to reinstate the balance of return rates to each factor. In contrast to this, assuming a capital-intensive education sector, an increment in the price of educational output will decrease wages, which leads to a rise in the capital profit of human capital. A two-sector model of endogenous growth displays a saddle-path stability for both sectors (Bond et al. 1996).

In the 1950s when the neoclassical growth framework was extended, the main keys for economic growth were innovation and technological change; natural resources were not given high consideration. However, this does not mean that they were totally ignored. At that time the main natural resource that researchers thought about was land. (Solow 1956: 67) stated:

"There is no scarce non-augmentable resource like land…the scarce-land case would lead to decreasing returns to scale in capital and labour and the model would become more Ricardian."

This indicates that resources were not ignored completely in the neoclassical models. Nevertheless, in general, the endogenous growth literature is not concerned with the influence of natural resources. The difference between an endogenous growth model such as AK theory and the Solow growth model is that in endogenous growth frameworks economic growth is an endogenous result of an economic system and not of factors outside the model. Yet, within the neoclassical growth theory technological changes that are exogenous are the driver of growth. In neither of these two frameworks are exhaustible natural resources the main factor of growth.

Stiglitz (1974) believes that one of the fascinating issues raised by the existence of exhaustible natural resources is that the fundamental notions of growth theory like "steady state" and "natural rate of growth" need to be reconsidered. In the Solow model, the long-term growth rate is controlled by the natural rate of growth and is not dependent on the savings rate. In considering two factors, one reproducible (labour) and the other non-reproducible (natural resources), if one is growing exponentially and the other one is not growing, what is the rate at which the economy grows? In countries with exhaustible resources, “efficient growth paths that differ with respect to savings rate also differ, albeit asymptotically, with respect to the rate of growth” (Stiglitz 1974: 123).

Romer described an endogenous long-run growth according to fundamental microeconomic structures. It is believed that endogenous growth models are closer to the reality, as confirmed by Grossman and Helpman (1993: 29), who stated: “Growth theory has taken a step in the right direction by including aspects of reality – imperfect competition, incomplete appropriability, international interdependence and increasing returns to scale – that surely are important to understand how much an economy will invest in knowledge of various kinds.” Although there is a consensus that a theoretical model of economic growth should move in the direction of endogenous frameworks, it has been illustrated that many leading endogenous models, such as (Romer 1986; Lucas 1988; Grossman and Helpman 1991a) are based on very strong assumptions that are not substantiated in applying these models (Solow 2000). Relaxing these strong assumptions would either lead to no endogenous model or infinite in infinite time. With regard to the empirical literature, it can be concluded that the majority of studies have continued to employ neoclassical models with augmentation.

2.6 Conclusion

The growth models were reviewed from the early scholars in economics to the most recent ones. According to the neoclassical growth model, the main drivers of growth are technology and capital accumulation. On the other hand, the endogenous models indicate that economic growth does not happen exogenously outside the economic system, but rather takes place within the system. Innovation and human capital within the economic system affect the growth rate of the country. However, natural resources have no role in determining the long-run economic growth rate in either of them.

On the other hand, some scholars are in favour of the idea that there is an individual growth model for each country, yet each country has a framework that can be followed after finding its capacities and reducing its deterrents. This explains why growth theories should be different for countries with different endowments. Yet, general growth models are used widely in the literature as a measure of economic performance for different countries. In other words, the growth route is highly heterogeneous.

Various extended versions of the Solow model, such as Cavalcanti et al. (2011a) and Esfahani et al. (2013), have been used broadly to investigate the role of natural resources in economic growth. Endogenous growth frameworks have not been commonly used in the empirical work on natural resources. The relationship between natural resources and economic growth has been studied mainly through neoclassical growth models. Therefore this research employs an augmented neoclassical model in order to study the long-term association between oil income and output in Iran. Oil income enters the growth model through saving and capital accumulation equations. The following chapter looks at the empirical studies on the role of natural resources in economic growth and the resource curse hypothesis.

Appendix 2

Harrod's Model

$S(t) = sY(t)$ $\quad 0 < s < 1$ (I-S-Condition)

$I(t) = v\dot{Y}(t)$ $\quad v > 0$ Investment function

$I(t) = S(t)$

$G(t) \equiv \frac{\dot{Y}(t)}{Y(t)} = \frac{s}{v}$

$g(t) = g_w = \frac{s}{v} = n = \lambda\tau$ Solution

Domar's Model

$\dot{\bar{Y}} = \sigma I$

$S = sY$

According to the equilibrium condition $I = S$ and $Y = \bar{Y}$.

The solution will be $\frac{\dot{Y}}{Y} = \frac{\dot{I}}{I} = \sigma s$.

The Standard Ramsey-Cass-Koopmans Model

Given a specific risk aversion θ the utility of households can be written as

$$U = A(0)^{(1-\theta)} \frac{L(0)}{H} \int_0^{\infty} e^{-(\rho-n-(1-\theta)g)t} \frac{c(t)^{(1-\theta)}}{1-\theta} dt$$

where ρ is the discount factor and $c(t)$ is consumption per effective labour. It is assumed $\rho - n - (1-\theta)g > 0$

The present value of lifetime consumption in terms of effective units it can be demonstrated as:

$$\int_0^{\infty} e^{-R(t)} c(t) e^{(n+g)t} dt \leq k(0) + \int_0^{\infty} e^{-R(t)} w(t) e^{(n+g)t} dt$$

Applying Lagrange, taking logarithms and differentiating with respect to time and substituting the rent of capital (marginal product of capital), the following equation can be written:

$$\frac{\dot{c}(t)}{c(t)} = \frac{f'\big(k(t)\big) - (\rho + \theta g + \delta)}{\theta}.$$

It is assumed that c, y and s are functions of t

$$\dot{y} = \alpha y \left[y^{\frac{\alpha-1}{\alpha}} s - \Gamma \right]$$

$$\dot{s} = (1-s)\left[\alpha y^{\frac{\alpha-1}{\alpha}}\left(s-\frac{1}{\theta}\right)-\alpha\Gamma+\frac{\Phi}{\theta}\right]$$

where $\Gamma = \mathrm{n}+\mathrm{g}+\delta$ and $\Phi = \rho+\theta\mathrm{g}+\delta$.

The Standard Overlapping Generations Model

The production function in terms of effective labour can be written as:

$$y_t = \frac{Y_t}{A_t L_t} = \left(\frac{K_t}{A_t L_t}\right)^{\alpha} = k_t^{\alpha}.$$

Population and technology are growing in relation to the following equations, respectively

$$L_t = (1+n)L_{t-1} \qquad\qquad A_t = (1+g)A_{t-1.}$$

Wage rate of labour and rent of capital (interest rate) are determined as follows:

$$(1-\alpha)k_t^{\alpha} = w_t$$

$$\alpha k_t^{\alpha-1} = r_t + \delta.$$

The following shows the constraint while the individual is working:

$$K_{t+1} = A_t L_t W_t - L_t \tilde{c}_t^{Y.}$$

And while the person is not working and using her saving the budget constraint is:

$$L_t \tilde{c}_{t+1}^{O} = (1+r_{t+1})K_{t+1.}$$

By combining these two we get:

$$\tilde{c}_t^{Y} + \frac{\tilde{c}_{t+1}^{O}}{1+r_{t+1}} = A_t w_t$$

$$\mathcal{L} = \ln \tilde{c}_t^{Y} + \beta(\tilde{c}_{t+1}^{O}) + \lambda\left[A_t w_t - \tilde{c}_t^{Y} - \frac{\tilde{c}_{t+1}^{O}}{1+r_{t+1}}\right].$$

Then the first-order necessary conditions are as follows:

$$\frac{\partial \mathcal{L}}{\partial \tilde{c}_t^{Y}} = \frac{1}{\tilde{c}_t^{Y}} - \lambda = 0$$

$$\frac{\partial \mathcal{L}}{\partial \tilde{c}_{t+1}^{O}} = \frac{\beta}{\tilde{c}_{t+1}^{O}} - \frac{\lambda}{1+r_{t+1}} = 0$$

$$\tilde{c}_t^{Y} + \frac{\tilde{c}_{t+1}^{O}}{1+r_{t+1}} = A_t w_t.$$

Consumption per effective unit of a working individual in equilibrium can be obtained by removing λ in the first- and second-order necessary condition as follows:

$$c_t^{Y} = \frac{(1-\alpha)}{(1+\beta)} k_t^{\alpha}.$$

And writing it in terms of output per effective worker will be

$c_t^Y = \frac{(1-\alpha)}{(1+\beta)} y_t.$

Stochastic Solow Model

Technology and labour are given exogenously as follows:

$$\log(A_t) = a_0 + g_t + u_{at}$$

$$\log(L_t) = l_0 + n_t + u_{lt}$$

$$\max \quad E[\textstyle\sum_{t=0}^{\infty} \beta_i^t f(A_t K_t H_t L_t | \Omega_0)]$$

subject to

$$s_t Y_t = K_{t+1} + H_{t+1} - (1 - \delta_K) K_t - (1 - \delta_H) H_t$$

where Ω_0 depicts the information at time 0.

$$E\left[\beta \frac{\partial f_t}{\partial K_t} (1 + \lambda_t s_t) + \beta \lambda_t (1 - \delta_K) - \lambda_{t-1} | \Omega_0\right] = 0$$

$$E\left[\beta \frac{\partial f_t}{\partial H_t} (1 + \lambda_t s_t) + \beta \lambda_t (1 - \delta_H) - \lambda_{t-1} | \Omega_0\right] = 0$$

Then writing physical and human capital in terms of effective unit of labour we will have:

$$k_t = \frac{K_t}{A_t L_t} \qquad \eta_t = \frac{H_t}{A_t L_t}.$$

Introducing new notation for output-labour, capital-labour and capital-output ratios we will have:

$$y_t = \frac{Y_t}{L_t} \qquad k_t = \frac{K_t}{L_t} \qquad v_t = \frac{K_t}{Y_t}.$$

Rewriting the Cobb-Douglas production function according to these notations will give us:

$$y_t = A_t k_t^{\alpha} = A_t v_t^{\frac{\alpha}{1-\alpha}}.$$

Endogenous Growth Model

An AK Model with Utility Maximization

$$u(c) = \frac{c^{1-\varepsilon}-1}{1-\varepsilon}$$

Obtaining the Euler condition:

$$\varepsilon \, {}^{\dot{c}}/_{c} = \rho - \alpha \bar{A} k^{\alpha-1}$$

in the Cobb-Douglas production function.

$$Y = C + \dot{K} + \delta k = AK^{\alpha}(uhN)^{1-\alpha}h_a^{\gamma}$$

$$H + \delta H = B[(1-u)H]$$

where Y is the final output, C is the consumables, K is investment in physical capital, δ is the depreciation rate, A and B are technological parameters, u is the fraction of time used working, h is a measure of the average human capital, N is the number in the labour force; therefore, the total effective labour is uhN, $(1-u)$, which is the fraction of time the labour force spends studying.

Romer expresses his model as follows:

$$Y(H_Y, L, x) = H_Y^{\alpha} L^{\beta} \int_0^{\infty} x(i)^{1-\alpha-\beta} \, di$$

Chapter Three

RESOURCE CURSE AND OIL ABUNDANCE

“Natural resource endowments would enable developing countries to make the transition from underdevelopment to industrial ‘take off’.”

(Rostow 1960)

3.1 Introduction

There is an understanding that natural resource abundance served as an engine of economic growth and made the “take-off” towards industrialization possible for some states such as Canada, Australia and the United States during the nineteenth century. Rostow (1960) believed that since natural resource endowments will make the transition from an underdeveloped to an industrial country possible, they can do the same for developing countries. It was mostly assumed that having natural resources should promote economic growth and reduce poverty. However, the literature changed in the twentieth century, and the existing literature from different locales provides considerable evidence that natural resource abundance leads to slower economic growth in developing countries.

Changes in the general views on the role that natural resources can play in the economy created a significant body of research investigating the relationship between resource abundance and economic performance. A new theory was born as a result of the poor performance of countries endowed with natural resources compared to those countries without natural resources, indicating that natural endowments are a curse. The resource curse theory was an explanation of the negative association between resource abundance and economic performance.

The narrative behind the impact of natural resource abundance on economic performance is a complicated one that the conventional economic models and regressions do not express well. Preliminary evidence indicates that possessing natural resources was considered a strength for a country. However, the belief changed, and by the 1960s natural resources were more of a curse than a strength. Interestingly enough, the new scholars proved that the existence of natural resources is a double-edged sword. This chapter is going to review the literature on natural resources in regard to economic growth and specifically scrutinize the resource curse hypothesis.

The remainder of this chapter is organized as follows. Section 3.2 introduces theories that explain the negative relationship between natural resources and economic growth. Sections 3.3 and 3.4 explain the resource curse through economic and political factors. Section 3.5 deals with the empirical evidence on this matter followed by drawbacks in studies in Section 3.6. Section 3.7 talks briefly about policies for managing natural resources well. Section 3.8 in turn draws some conclusions.

3.2 Resource Curse and Growth

Growth literature provides evidence that resource-rich countries grow more slowly than their counterparts, giving rise to the resource curse hypothesis. Over the years, many scholars have developed a number of theories in an attempt to describe the lagging growth experienced by resource-abundant countries. The first theories that attempted to explain the negative relationship between natural resources and economic growth came from two structuralists: Prebisch (1949), concentrating on the falling trend of exchange between primary and manufactured goods, and Hirschman (1958), focusing on the volatility of primary products. In addition, terms of trade between primary products and manufactured goods deteriorate over time. This means that for countries that export only primary goods, over time their goods become relatively cheaper than those in countries who export manufactured goods. Nonetheless, neither of these hypotheses was unequivocally confirmed by empirical studies (Moran 1983; Behrman 1987; Lutz 1994; Fosu 1996). The negative outcome of producing and exporting primary products was mentioned in other works, such as (Hirschman 1958; Seers 1964; Baldwin 1966; Gelb 1988). On the other hand, some scholars strive to demonstrate that export of primary goods can promote economic growth (Roemer 1970).

In the 1960s, an idea emerged suggesting that natural resources might be more of a curse than a blessing. Up to the 1970s the main concern of the literature was primary products, but after the first oil shock the concern moved towards oil. Higher prices in oil generated large-scale revenues, which gave rise to the speculation of a negative impact of these revenues on the development prospects of the oil exporters. To address this concern, a new literature emerged to investigate the association between revenues from hydrocarbons and economic development and growth (Mabro and Monroe 1974; Neary and Van Wijnbergen 1986).

The term "resource curse" was coined by Auty (1993) to explain how countries rich in minerals struggled to use their endowments to boost their economy. Later the 'resource curse' theory was used for all kinds of natural resources. The resource curse theory or "paradox of plenty", which refers to the negative association between natural resources and subsequent economic growth, came to existence in a large amount of literature (Wheeler 1984; Auty and Evans 1994; Sachs and Warner 1995b; Leite and Weidmann 1999; Rodriguez and Sachs 1999; Sachs and Warner 1999; Gylfason 2000).

Looking at the economic performance of resource-rich countries over the past two centuries, researchers were convinced that they had experienced lower economic growth than those without an abundance of natural resources. There are a number of explanations for why countries with abundant natural resources find it a curse. As demonstrated in Figure (3.1), this chapter divides these explanations into two categories. The first one is economic explanations, such as the Dutch Disease, volatility and ignorance of human capital. The second one is political explanation of the resource curse, such as rent-seeking activities, poor institutional quality and corruption. In what follows, we begin by looking at the economic causes behind the so-called resource curse, which covers subjects such as the Dutch Disease, volatility and human capital. Then, we move onto political subjects such as rent-seeking activities, the quality of institutions and corruption.

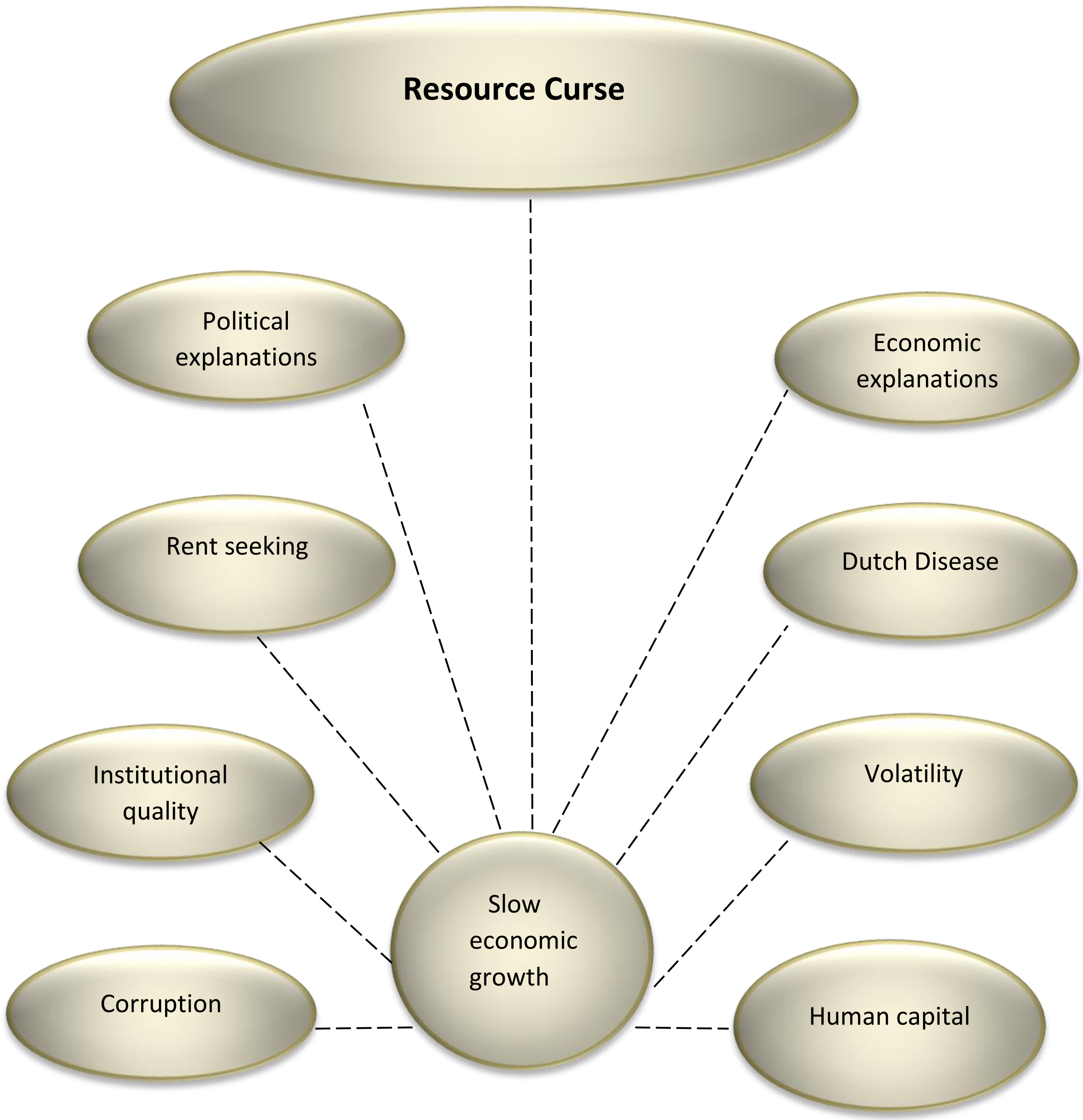


Figure (3.1) Resource Curse Channels.

3.3 Economic Explanations of Resource Curse

3.3.1 Dutch Disease

Dutch Disease is one of the explanations for the resource curse; it explains the relationship between oil prices and the exchange rate (see (Corden and Neary 1982; Neary and Van Wijnbergen 1986; Krugman 1987; Matsuyama 1992). In the 1960s following the overvaluation of the Dutch guilder due to a new discovery of gas in the Netherlands, a new pattern was introduced called the “Dutch Disease”. The so-called “Dutch Disease” was possible result of a sudden increase in revenues from exhaustible resources, which hampered the industrial sector, considered the engine of economic growth, either through rises in private and public spending or the absorption of production factors (Neary and Van Wijnbergen 1986). In the light of the Dutch Disease an abrupt increase in revenues from natural resources can lead to real exchange rate appreciation.

Needless to say, the association between oil prices and the exchange rate is a complicated one. It seems they are moving in the opposite direction in the short run, but this is not true for the long run. The suggested process is assumed in an economic model that distinguishes between internationally traded products on the one hand, and non-traded products and services on the other.

The price of traded goods (manufactured and agricultural) is determined on the international market in US dollars. On the other hand, the price of non-traded goods (services) is determined in each country according to the law of supply and demand. After an oil export boom in the economy the demand for both traded and non-traded goods will increase. The higher demand for traded products can be met easily through higher imports; however, the higher demand for non-traded goods needs to be met by the supply within the country, which does not happen immediately and needs some more time. Therefore, the price of non-traded goods relative to traded goods increases. This process, i.e. increases in the prices of non-traded products relative to traded ones, is labelled “real exchange rate appreciation”. In other words, the Dutch Disease occurs when a country that is exporting scarce natural resources faces a currency appreciation. By nature, a stronger currency is not a bad thing: it makes imports cheaper. The flip side of this appreciation is when some industries in the country become less reasonable on the global market.

3.3.1.1 The Geometry of the Dutch Disease

Figure (3.2) illustrates the famous traded-non-traded goods framework. The first figure on the left-hand side displays the production possibility frontier (henceforth PPF) of the country before the spike in oil prices, with a probable combination of traded goods (non-oil) on the horizontal axis and non-traded products on the vertical axis. The curve with dotted line represents the consumer indifference curve. Point E is where the economy is in its initial equilibrium, which is at a point of tangency of the indifference curve and the PPF. On the vertical axis E_N is the level of non-traded goods and E_T on the horizontal axis shows the level of non-oil traded production. In other words, the real exchange rate is the slope of the PPF at point E (price of traded goods to non-trade goods). A sharper curve will translate into depreciation in the real exchange rate.

To explain the Dutch Disease it is assumed there is an oil shock in the country, which translates to an increment in the total output of traded goods comparing to the sum of oil and non-oil traded production. The PPF shifts to the right side by the amount of increase in oil prices, H. The new equlibrium is presented on the right side as point E^*. As can be seen in the figure, non-traded goods have climbed to EN*. The entire quantity of traded goods (oil and non-oil) has also increased by the amount of $E_T^* + H$. However, the quantity of non-oil traded production has decreased to E_T^*. It can be seen that the real exchange rate has increased because the slope at point $E^*$is not as sharp as at point E, suggesting an increase in the price of non-traded goods.

It is evident that real exchange appreciation has made a readjustment of output in the non-oil section of the country. Higher prices of non-traded goods induce workers and capital to shift to non-traded production, which means that that capital and those workers will leave the non-oil traded sector. In summary, an increase in oil spending causes a shift of production away from traded production such as agriculture and manufactured exports towards services and non-traded production. These changes are certainly not a disease. An increase in non-traded goods at the expense of non-oil traded goods does not by itself establish a “mistake” of market forces as Humphreys et al. (2007) indicated. A rise in traded production is met by higher imports; however, a rise in non-traded commodities should be met by higher domestic output of those commodities.

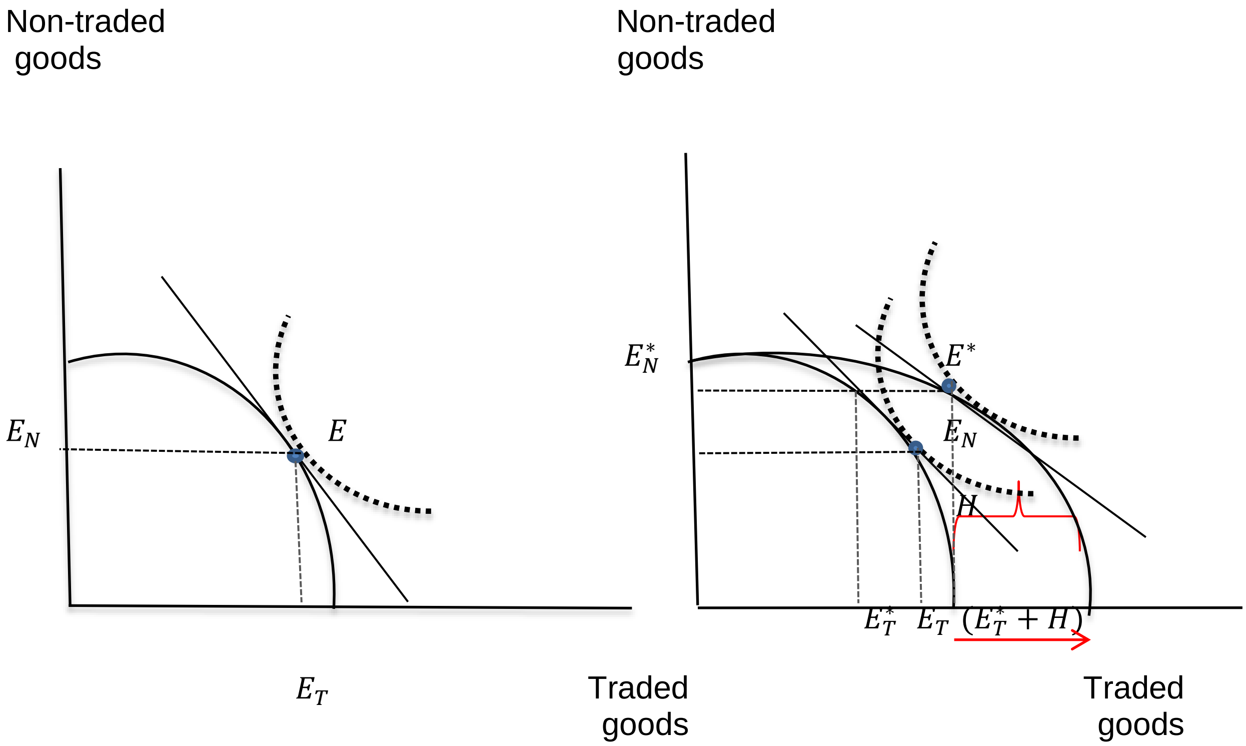


Figure (3.2): The Dutch Disease.

Source: (Humphreys et al. 2007)

These shifts in resources can only become a disease if there is something superior about the traded production sector that is being squeezed. For instance, assume the economy is exporting textiles before the boom in the oil sector. After a boom in the oil sector, labourers and capital investors are tempted to migrate to the non-traded goods sector. If the textile sector contributes significantly to economic growth and development, any decrease of it would spell trouble for the economy. Therefore, a spike in oil prices would cause a fall in a technologically leading sector of the economy, with negative effects in the long-term. However, there is a solution to this problem, as the government can curb the spillover of labour from the textile sector to non-traded production. The alternative option would, however, be to make targeted subsidies available for the textile sector.

Overall, the real concern about the Dutch Disease is when the non-oil export sector will shrink, thereby squeezing the main foundation of technological improvement in the country. Nonetheless, this concern is significantly overblown when oil incomes are correctly invested as a part of a country's development plans. If oil revenues are invested in infrastructure, the productivity of labour, not only in the traded but also in the non-traded sector, will increase. If oil income is used by government to import all of the investment goods, there will not be any direct spending effect of oil revenue. There is no doubt that consumption increases, but only to the extent that the non-oil sectors (traded and services) grow subsequent to the higher public investment funded by oil revenue (Humphreys et al. 2007).

The right side of Figure (3.3) depicts an upward and rightward shift in the PPF. At the same time, both the consumption and production of non-oil traded production and services surge. Point E** is the new real exchange rate, which might or might not rise compared to the initial point at E, although it is not very important, since the non-oil traded production grows in any event. It develops as an outcome of amplified productivity owing to public investment.

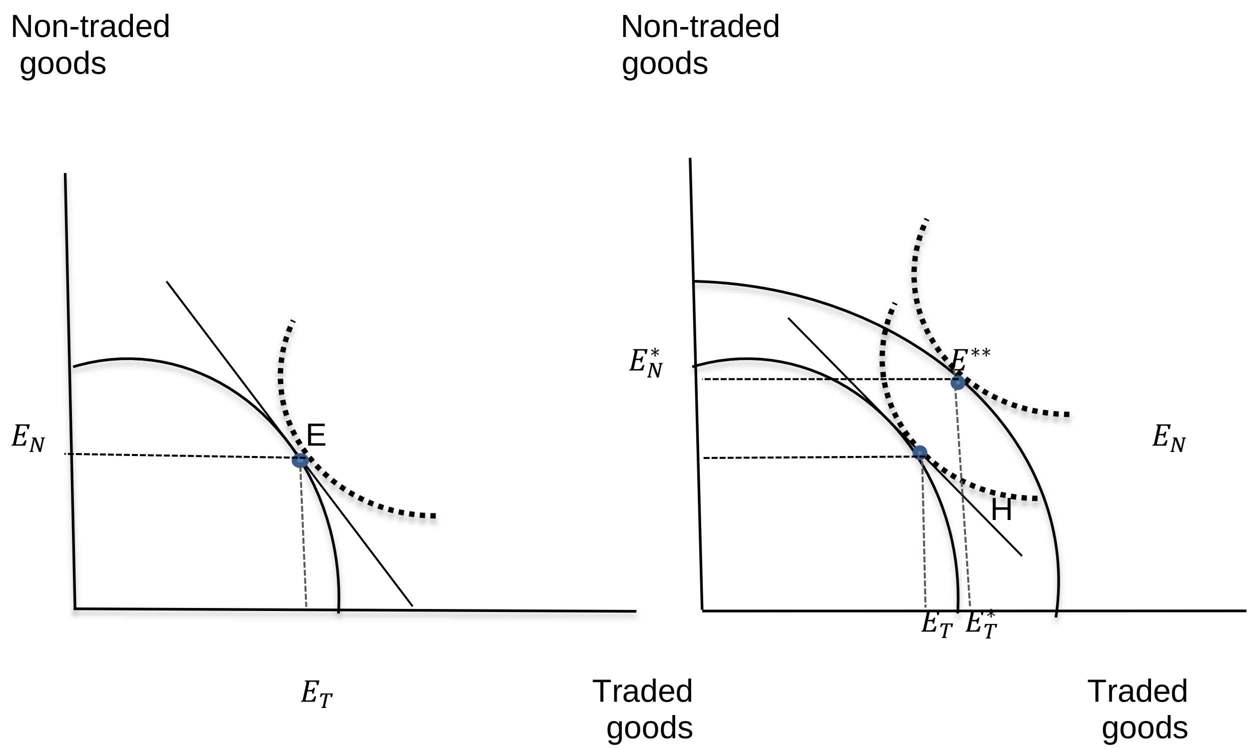


Figure (3.3) Public Investment through Spike in Oil Prices.

Source: (Humphreys et al. 2007: 198)

There might be a slight Dutch Disease if the higher spending on public investment falls relatively on non-traded production rather than completely on imported capital goods; however, this effect originates from the investment boom rather than a consumption boom. In these circumstances, the increase in investment spending will lead to a rise in the real exchange rate and a temporary squeeze of tradable production, until the productivity-enhancing impact on tradable goods kicks in. All of these can be relatively quick since the benefits of investing in infrastructure can come on line quite fast. Therefore, any squeeze on tradable goods is probably temporary.

As shown in Figure (3.4), it is also likely that a significant spike in oil prices, especially in poor countries, will only cause depreciation in the real exchange rate if the public investment funded by oil revenue raises the productivity of the non-traded sector. In low-income nations, the most important non-traded good is staple food production in the consumer’s basket. However, due to high transport costs in rural areas, staple food production is mostly used by farmer households rather than being sold in the market. It is important to mention that food is the main element of consumption in poor areas. Therefore, if oil income is invested to increase the productivity of farmers by funding seed or subsidies, the PPF will shift upward, as can be seen in the figure. The general impact of significantly high oil prices could be a reduction in the relative price of non-tradable food and consequently a real depreciation. The slope at E*** is sharper than the slope at E. Furthermore, there is higher production in both non-traded and non-oil traded goods. It is worth mentioning that there is no squeeze in non-oil traded production.

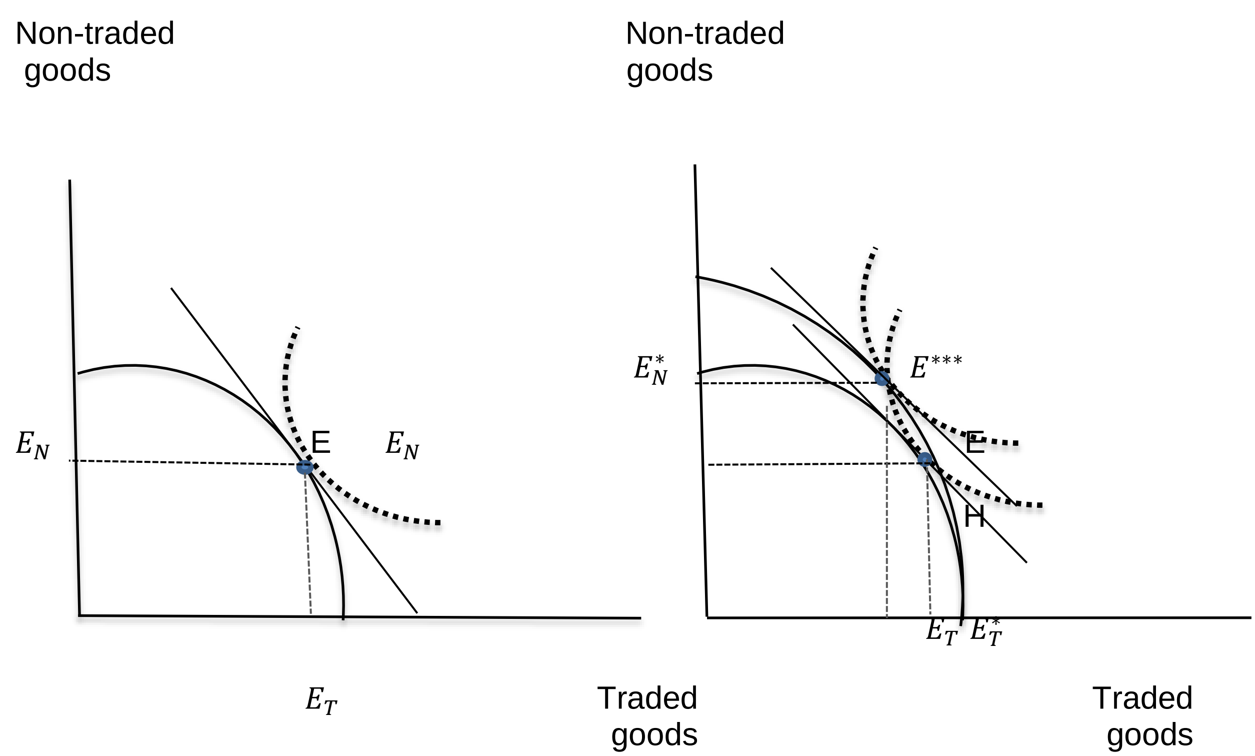


Figure (3.4) Real Depreciation Following a Rise in Non-Traded Food.

Source: (Humphreys et al. 2007: 199)

To sum up, the Dutch Disease is mostly a concern when the oil income is used to fund consumption rather than investment. In the aforementioned circumstances, the non-oil traded part may squeeze on a constant foundation, with a negative impact on long-run growth. However, this is very improbable if the oil income is correctly invested in infrastructure or any public good. Then positive effects of amplified public investment on non-oil traded sector are probable to outweigh any adverse consequences of real exchange appreciation. The empirical tests do not offer strong support for the Dutch Disease being a justification of the curse of natural resources (Leite and Weidmann 1999; Sala-i-Martin and Subramanian 2003).

In addition, another study by Auty (2001b) rejects this theory by illustrating the complication and variation of cases in countries with natural resource intensity, with some exceptions such as Norway. There are more explanations for the theory of the resource curse, which can be assumed to be symptoms of the Dutch disease. One of them is the lack of motivation for entrepreneurship (Sachs and Warner 2001). Another explanation is a reduction in saving; and therefore physical investment (Gylfason 2002; Papyrakis and Gerlagh 2004). In the same line of research it was demonstrated that having natural resources causes lower investment in education and as a result lower human capital (Gylfason 2001; Bravo-Ortega and De Gregorio 2007). It is worth mentioning that the Dutch Disease hypothesis does not suggest that an oil boom is inclined to reduce the level of competiveness in non-resource sectors; and even if it does, economic policies must be able to soften this inclination.

It is important to mention that in the aforementioned scenarios labour moves easily between the traded and non-traded sector, and also that labour is exogenously given and it is constant. Behind these assumptions lies an assumption of perfect labour mobility and inelastic labour supply. Although these rules can apply to some countries, they look unrealistic for others. They defiantly ignore the chance that societal arrangements matter for any responds of an economy to alteration in natural resource revenue. This is exactly what the Dutch disease frameworks pursue. However, aspects of both labour supply and labour mobility are ignored in the current Dutch disease literature. It is important to mention that connecting labour market patterns to natural resource endowments can explain specific structures of the society. It is necessary to mention that gender grouping of the labour market and gender-based occupational segregation are two important factors of the labour market in regard to natural resources which are beyond the scope of this thesis.

3.3.2 Volatility

When oil prices used to be regulated mostly by the main international oil companies there was not much volatility in prices, so it was not an important factor. However, after the first and second oil shocks, volatility became an inevitable factor of the oil market. Furthermore, as a consequence of the collapse of the OPEC oil pricing system, crude oil prices are determined in the international market, which induces even more volatility in oil prices. It turns out that volatility has a significant impact on the role that oil plays in the economy and this needs to be considered in econometric models.

A strand of literature indicates that volatility is the key reason for the poor performance of resource-rich countries (Blattman et al. 2007; Van Der Ploeg and Poelhekke 2009). As Humphreys et al. (2007) illustrate, there are three channels for volatilities in resource revenues. The first one is the rate of extraction; volatility can arise due to the nature of extraction. Usually in the first years after an oil discovery the stock is abundant and this speeds up the extraction. Nevertheless, the pace of extraction decreases when the stock gets low and becomes difficult to access. The second channel is the differences in the timing of payments by buyers and contractors, and the last one is the oscillation in prices that can happen due to political turmoil, the discovery of new resources, a change in supply and demand etc. For instance, the Iranian revolution in 1979 caused an oil shock because the country is a major oil exporter.

In addition, another example of volatility affecting an oil exporting country is economic sanctions on a major oil exporting country, for instance the sanctions on Iran’s oil in 2011. Due to the nuclear programme, the US and EU imposed tough sanctions on Iran’s oil export, which made her GDP slump overnight. Volatility was translated into the country’s gold and exchange rate market. It is worth mentioning that the embargo on Iran’s oil also affected Saudi Arabia and Iraq’s oil production as they had to increase their shares to fulfil the abrupt shortage in the international market.

Furthermore, volatility can be aggravated by international borrowing by a resource-abundant country. Developing countries rich in resources like oil and gas can use their wealth as collateral and borrow against their future income. This rarely can happen for developing countries without natural resource endowments. The problem here is that when prices are high the risk is low; therefore, the value of future oil income surges. As a result, this accelerator effect reduces the interest on loans, and in the future will intensify the impact of the boom. On the other hand, once prices fall, the value of collateral reduces. Consequently, the decelerator effect reduces the interest rate and again intensifies the impact of the downturn.

Both the government and private sector need to deal with the volatility in the oil market. A diversified economy can be better off than one that only focuses on oil, all things being equal. Blattman et al. (2007) investigated the economic growth of 35 countries during the period 1870-1939 and their results showed that countries that concentrate on commodities with considerable price volatility suffer from volatility in their terms of trade, and foreign direct investment. They also concluded that those countries experience lower economic growth than those that focus on commodities with less volatile prices or those that are industrialized.

Oil is produced in different countries all around the world and any attempt to raise the price or reduce the volatility rationally needs collaboration from, if not all, certainly most oil producers. Most endeavours to establish international cartels in order to prevent volatility in the oil market have not been successful. The Organization of the Petroleum Exporting Countries (OPEC) was established in 1960 in an attempt to "coordinate and unify the petroleum policies of its member countries and ensure the stabilization of the oil market in order to secure an efficient, economic and regular supply of petroleum for consumers, a steady income for producers and a fair return on capital for those investing in the petroleum industry" (Organization of the Petroleum Exporting Countries 2017).

Many economists believe OPEC is a profit-maximizing cartel, and according to the definition of a cartel, cartels divide the market, defend prices and establish quotas. However, OPEC has by no means divided the market or defended oil prices (Alhajji and Huettner 2000). There is no agreement over whether OPEC's efforts to increase prices or reduce the fluctuation in the oil market have succeeded. Some of the sudden increases and decreases in the world market in the last 50 years have arguably been attributable to alterations in OPEC's dynamics[1] (Frankel 2010). In the meantime, some new oil producers outside OPEC proposed a reduction in OPEC's shared monopoly power even when it was performing in union. However, there are a number of measures that can be taken to act as a buffer against volatility, such as wealth funds and appropriate government policies.

3.3.3 Human Capital in Energy-exporting Countries

The way we explain education is challenged by the paradigm shift to explaining development in less economic terms. Human development is the key concern and sustainable development is presented in terms of people's choices (UNDP, 1990). Amartya Sen proposed the capability approach which provides a conceptual framework of aforementioned view. According to him human development is the process of expanding the real freedoms that people enjoy expressed as their capabilities in doing so. In addition, he believes education expands the individual's 'functioning's'; and therefore, enhances their capabilities.

Sen (2001), a development economist, highlights the significance of social returns from education for economic growth. Economic growth frameworks have expressed a positive correlation between human capital, economic growth and development. According to Gylfason (2001), countries with natural resource endowments have lower investment in education as a percentage of GNP. His results show that natural

[1] For example, the Arab oil embargo in 1973, which was followed by a collapse in the 1980s when members refused to follow their quotas.

resources seem to crowd out human capital, thereby slowing the process of economic development. In Gylfason's view, in countries where natural resources are the main asset, the development of other resources such as human capital will be ignored. In the same line of research, Birdsall et al. (2000) realized that resource-rich developing nations have lower public expenditures on education than other developing countries.

Seminal works of Romer (1986) and Lucas changed the neoclassical growth theory by highlighting mechanism and incentives which are connected to dynamics of growth. Their methodology puts human capital as a critical factor to create technological development which translates to steady state economic growth. These frameworks of growth share the notion of Arrow (1962) of existence of significant externalities in the accumulation process. The most common way of measuring human capital is school enrolment ratios due to availability in many countries. However, this is not a perfect index since it only reflects the current flow of education. To this end, many scholars such as Psacharopoulos and Arriagada (1986) created more elaborate measures for human capital.

Wade (1992) indicated that in Latin America, the owners of natural resources are controlling states, and they do not have any motivation to invest in education. The logic behind this idea is that resource-rich countries have plenty of foreign exchange; therefore, they do not need to invest in other skills to be able to export manufactured goods. Two reasons for this are the policies of the education system and institutions. In essence, spending on education does not always lead to good educational quality; in addition, education expenditure and quality are facilitated by institutions and policies. In other words, the roots of the political and economic channels for the resource curse are interrelated and usually overlap. Gylfason (2001) believes that oil-abundant countries with ample oil income ignore the importance of investing in human capital.

Although the majority of studies in the resource curse literature consider education to be the only factor for human capital accumulation, this is not in fact the case. Another important dimension of human capital accumulation is health as a driver of sustainable growth. Kim and Lin (2017) study the impact of natural resource abundance on education and health, applying dynamic panel co-integration methods in order to consider the heterogeneity in the association across nations. Their results indicate that resource dependence has a significant impact on both education and health. However, there are significant cross-country differences in regard to education and health in relation to natural resources. Interestingly, it is shown that the education-improving impact of resources is more significant in states with higher income and higher institutional quality. On the other hand, the health-decreasing impact of resources is more dominant in states with lower income and poor institutional quality.

One important aspect of human capital is education which is prerequisite for rapid economic growth all around the world. In regard to Iran, the higher education sector has undergone remarkable growth in the last two decades. The country has witnessed a rapid extension of the private sector. The state is responsible for both financing and administration of elementary and secondary education through the Ministry of Education. According to UNESCO data published by the World Bank in 2014 Iran’s education sector spent 2.95 percent of its GDP on education. This number indicates 19.7 percent of government expenditures. In the same line of research data from World Bank on adjusted saving, education expenditure refers to the current expenditures in education, such as wages and salaries, excluding capital investments in buildings and facilities.

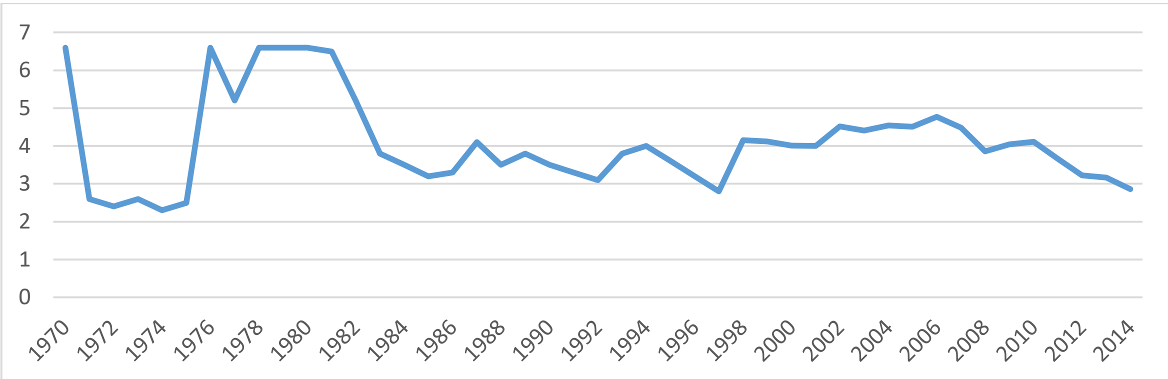


Figure (3.5) Adjusted Net Saving: Education Expenditure

Source: The World Bank

In the period of 1976 to 1982 the education expenditure was the highest, then after 1982 it dropped significantly but in the years to follow it remained relatively stable. Although there is significant evidence at the micro level to support a connection between government education expenditures and human capital, this does not translate to a link between education expenditures and economic growth in the macro-level data.

3.4 Political Economy

Another channel through which the resource curse hypothesis can be felt is political economy, which encompasses rent-seeking activities, corruption, civil wars, inappropriate policies and armed conflicts. There is a vast body of literature on how natural resources invite rent seeking and corruption, which have adverse effects on the economic performance of nations (Ross 1999; Baland and Francois 2000; Auty

2001a; Torvik 2002; Robinson et al. 2006; Wick and Bulte 2006). Miguel et al. (2004) show that economic shocks play a role in creating conflicts. Collier and Hoeffler (1998) present evidence indicating that natural resources are the source of armed conflict. They claim there is a non-linear relationship between natural resources and armed conflicts; however, they do not clarify why the results for prosperity among resource-rich countries are different. In the following, three channels of political economy are discussed.

3.4.1 Rent-seeking Activities

Lane and Tornell (1996) demonstrated that in a country with a few elites, where all have access to production, both the rate of return on productivity and growth can be reduced. The logic behind this is that when productivity is higher, each group tries to attain a superior share of production by demanding more transfers, while more transfers raise the tax rate and decrease the net return on capital. Therefore, the direct influence of productivity can be outweighed by redistribution effects. One line of research highlights the adverse impact of rent-seeking activities correlated with natural resource endowments (Torvik 2002; Robinson et al. 2006). Torvik (2002) demonstrates in his framework that a large amount of natural resources raises the number of entrepreneurs involved in rent-seeking activities and reduces the number of entrepreneurs engaging in productive activities.

It is revealed that the subsequent fall in income is higher than the increase in income from natural resources. As a result, natural resource endowments create lower welfare. Unproductive and ineffective authority can explain the extent of poor performance. Since the oil revenue goes to the state, it definitely affects state capacity. Inasmuch as earnings from oil abundance encourage rent-seeking behaviours, the government converts to a kind of “honeypot” in which rival interests attempt to take a substantial share of resource incomes by taking the state’s portion. The result will be a vicious cycle where everyone tries to achieve parts of the bureaucracy while states, in turn, pay their cohorts by funnelling favours their way. This can translate into the absence of corporate cohesion and power to exercise efficient public policy. According to Baland and Francois (2000), ‘‘when a large proportion of individuals are engaged in rent-seeking already, such an increase inclines the economy towards more rent seeking and may actually lead to a decline in aggregate income” (Baland and Francois 2000: 529).

Since the recipients of resource rents become politically powerful and are usually governments, they can prevent economic reform or turn it to their advantage. The “rent-cycling” theory stresses the association between the economy and politics in developing resource-abundant countries. This theory was born out of an observation that resource rents and foreign aid influence policy implementation (Tollison 1982).

Kruger et al. (1991) stress the point that resource rents may be disconnected from what generated them; therefore, the chance of a political contest to capture them is high. As a result, income from resources will affect both the structure of the economy and political incentives of the government. Rent-seeking behaviour, particularly by powerful politicians, creates corruption and inadequate governance, which leads to crowding out social capital. As a result, institutional quality deteriorates, leading to corruption.

3.4.2 Corruption

There is an understanding that having natural resources in a country increases corruption: Leite and Weidmann (1999) discovered that resource dependence has a significant statistical effect on corruption. Countries with the greatest resource abundance, in particular oil exporting ones, have the highest level of corruption (Karl 2007). In the same line of research, Arezki and Bruckner (2009) believe that oil revenues increase corruption in resource-rich states. As mentioned before, oil is the catalyst for a long-standing tendency of the government to become overextended. A lack of well-developed financial and insurance markets, substantial fluctuations the terms of trade, and the government access to resources during high prices period, have contributed to the expansion of public sector (Ersel and Kandil 2006). Studies suggest that the level of corruption is much higher in states in which the civil service is quite large, and for employment and promotion, instead of relying on merit, it relies on the political elite’s interest. Therefore, attempts to restructure the civil service are unfeasible in order to keep the patterns of corruption.

Political economy has recognized that good governance and democracy are crucial for tackling the corruption that can be the potential result of resource endowments. Corruption can happen in different ways in a country, one of which is in the policies that the government applies. Another one that happens quite often in resource-rich countries is bribing. Policy corruption can include corrupt impacts on the enactment and pattern of policies. It can also be administrative corruption, which refers to misuse of administrative office to gain benefits that are not legal to approve operational activities. Administrative corruption can also be a direct corrupt action by agencies for their own benefit when they are responsible for trading a country’s oil.

Papyrakis and Gerlagh (2004) find evidence that natural resource abundance raises corruption due to poor quality of institutions, and reduces investment, human capital and R&D.

In the worst case scenario, corruption can lead to a “corruption trap”, whereby payments at the topmost political institutions inspire corruption, to the point that a significant fraction of both the private and public sector are engaged. It should be mentioned that corruption not only happens in the production and export of natural resources but is also due to the tremendously high-level and challenging-to-absorb investment in both upstream and downstream stages, where it is hard to track resources that have disappeared. The huge income from oil creates a voracious rent seeking that destroys the development of institutions through corruption (Leite and Weidmann 1999). In resource-rich countries, the earnings from resources, especially in a concentrated form, acts like a magnet for political competition. Furthermore, political parties, in order to stay in power, propose different ways of redistributing income from resources to favoured groups.

3.4.3 Institutional Quality

One strand of research explains the resource curse hypothesis through the differences in countries’ institutional arrangements. Institutions have received substantial attention not only in growth literature but also in the economies of countries with natural resource endowments. There is a growing literature on the prominence of institutions in elucidating the resource curse hypothesis as emphasized by the World Bank publication (Harford and Klein 2005). Economy is inevitably embedded in a group of non-market organizations. Yifu Lin and Nugent

(1995: 2306-7) define institutions as a "set of humanly devised behavioural rules that govern and shape the interactions of human beings, in part by helping them to form expectations of what other people will do". As Rodrik (2007) indicates in his book, institutions are necessary for markets since they are not "self-creating", "self-regulating", "self-stabilizing" or "self-legitimizing".

The direction of the relationship between oil revenues and institutional quality has been controversial. Lately, economists and politicians have drawn attention to the relationship between good governance, high-quality institutions and economic growth. Good governance comprises powerful rule of law, strong property rights, low corruption and policies that meet the needs of the economy. The result of good governance is an environment that provides opportunity for investment. According to Askari (2007: 230), the investment climate is "the set of factors for firms to productively invest, employ and expand". It is important to look at sets of factors in institutions that increase incentives to invest both for domestic and foreign investment.

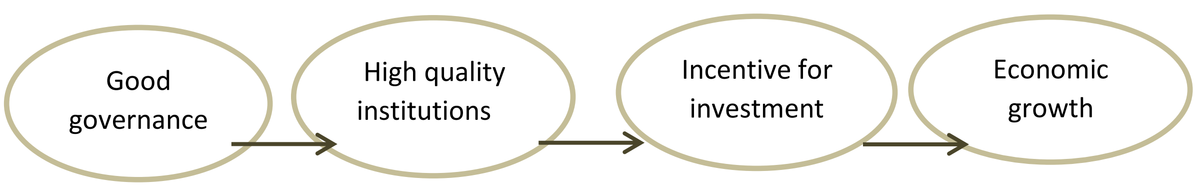


Figure (3.6) Incentives for Investment

The question here is: what are high-quality institutions and good governance, and how do we measure them? Human beings believe that today's formalized rule constructions control the performance of organizations and institutions. This means that many constructions have developed into their current form of structure, which existed at some point in time in history to satisfy social aims. There is a cluster of institutions that matter for long-run economic growth, such as independent judiciary, property rights enforcement, institutions that provide access to health care and institutions that can provide equal opportunity for education.

Rodrik and ebrary (2003) indicate that the foundations of long-run economic growth are institutions that deliver reliable property rights and concrete rule of law, and bring into line economic incentives with social costs and benefits. Institutions in countries with or without natural resources are “the rules of the game in a society, or more formally, the humanly devised constraints that shape human interaction” (North 1990: 3). Institutions are vital for economic growth since they structure human interaction. The institutional strength and efficient regulations can act as shock absorbers for the economy of a country. As Rodrik (2007: 153) indicates in his book,

> *“a clearly delineated system of property rights; a regularity apparatus curbing the worst forms of fraud, anticompetitive behaviour, and moral hazards; a moderately cohesive society exhibiting trust and social cooperation; social and political institutions that mitigate risk and manage social conflicts; the rule of law and clean government, these are social arrangements that economists usually take for granted, but which are conspicuous by their absence in poor countries.”*

Measuring institutional quality is a controversial topic; different researchers have used different methods and indicators to measure it. Empirical research on the role played by institutions in producing growth suffers from a number of issues: i) a lack of institutional quality indexes; ii) endogenous variables; iii) collinearity; and iv) the existence of omitted variables (Alonso and Garcimartín 2013). A comprehensive cross-sectional and time series data set, “the Quality of Government Institutes” (henceforth QoG), was presented at the University of Gothenburg. They used a notable number of indicators linked to the quality of government. The variables can be categorized into three different collections. The first group is the central feature of QoG, including corruption and democracy. The second group is variables that suggested the development of QoG, such as forms of government, religion and social fractionalization. The last group is variables relating to the posited consequences of QoG, like human development and environmental sustainability.

Acemoglu et al. (2001a) in their study introduced the risk of expropriation as a crucial indicator of institutional quality. Chong and Calderon (2000) used different indexes for institutional quality in their research. They used the International Country Risk Guide (ICRG) and Business Environment Risk Intelligence (BERI). Their data set covered measures on corruption, bureaucracy, risk of expropriation and other issues. In another study, Rodrik et al. (2004) used indices of the rule of law and property rights for measuring institutional quality. Acemoglu et al. (2001a) considered expropriation risk to investors as an institutional quality indicator. Acemoglu et al. (2003) in their study introduced a “cluster of institutions” for the quality of institutions, which is the extent of restraints on the administration. Their hypothesis is that weak institutions create inequality and dictatorship, and there are no constraints on politicians who wish to plunder the country.

Mehlum et al. (2006b) took a different approach to clarify the role of institutions; they distinguish between two types of institutions: producer-friendly and grabber-friendly. According to them, in producer-friendly institutions, rent seeking and production are complementary activities. On the other hand, in grabber-friendly institutions, rent seeking and production are competing activities. Institutions are grabber-friendly due to the poor rule of law, inefficient bureaucracy and corruption, which encourages specialization in unproductive activities that are bad for economic growth. On the other hand, producer-friendly institutions can absorb entrepreneurs, which creates higher growth. Their results show that resource-rich countries only perform poorly if they do not have good-quality institutions (e.g. poor rule of law or high risk of expropriation).

Kunčič (2014) categorized institutions into three different groups – legal, political and economic institutions – and introduced a number of proxies for each group. Another index used for institutional quality is the Worldwide Governance Indicators (WGI). Although it has been harshly criticized by other researchers such as Oman (2006), Knack (2006) and Kurtz and Schrank (2007), most of the critiques of the WGI were soundly rejected by Kaufmann et al. (2011). It is important to mention that all the existing indicators capture the actual quality of institutions imperfectly.

One explanation of why a high economic growth rate is not a systematic consequence of natural resource abundance is the wrong policies adopted by government, such as the lack of a sound tax system in oil exporting countries. In most resource-rich countries, natural resources are under public ownership; therefore, the government pays its expenses mainly from the resource earnings, which reduce the need for taxation. Since the ruling elites do not need to depend on tax revenue, they carry on with their instructions without much representation (Mahdavy 1970; Salehi Esfahani 2006). Since the government does not rely on taxes and gets a large portion of its income from oil, it does not feel responsible for providing enough public goods (see, for instance, (Lane and Tornell 1996; Leite and

Weidmann 1999; Tornell and Lane 1999; Collier and Hoeffler 2004). Apart from the influence of natural resource abundance on policy outcomes, revenue from natural resources has affected political institutions in resource-rich countries. Another policy in most of the developing resource-rich countries is the provision of generous and inefficient subsidies for energy and preventive trade policies, as Salehi Esfahani (2006) mentions.

There was no consensus over whether good institutions lead to economic growth or economic development and growth will create good institutions until Ngerman and Sokoloff (2000) and Acemoglu et al. (2001a) offered convincing evidence that institutions are the reason for the poor performance of resource-rich countries. In the former, the causation is shown to be inequality driven by scale economies, and in the latter, the authors explain the causality by observing historical dissimilarities that influenced the establishment of institutions in colonies of the European countries.

Efficiency in administrative and judicial systems is essential for good institutions. However, constructing a robust bureaucracy and judiciary creates some difficulties for developing resource-rich countries. First and foremost, improving these institutions needs capable administrators in national governments to plan and carry out policies. Although there are specific approaches for initially starting and slowly rebuilding the system, some difficulties need to be faced in applying these methods. For instance, it is challenging for leaders to grant autonomy to juries and bureaucrats to allow them to proceed with required alternations.

3.5 Empirical Studies

Scholars have concentrated on investigating empirically the relationship between oil price fluctuations and main macroeconomic variables such as economic growth, rate of employment, government expenditure and inflation. However, the literature has still not reached a consensus. The following section will review some studies on the role of oil income in the economics of developing countries. The outline for the empirical analysis of growth-accounting models is explained in Barro and Sala-i-Martin (1995).

A cross-sectional specification framework has frequently been used in resource curse and economic growth literature following the influential work by Sachs and Warner (1995b). They demonstrated a negative relationship between natural resource abundance and economic growth for 97 countries by introducing different explanatory variables for resource abundance. For instance, (Gylfason et al. 1999; Rodriguez and Sachs 1999; Bulte et al. 2005), among others, follow Sachs and Warner's approach by estimating the growth equation as:

$$\left(\frac{1}{T}\right)\log\left({Y_T^i}/{Y_0^i}\right) = \delta_0 + \delta_1 \log\left(Y^i\right) + \delta' Z^i + \varepsilon^i \qquad (3.1)$$

Their explanation was that economic growth in country i in the period t to T would be a negative function of initial output Y_0^i and a vector of other structural factors of the economy (Z^i). They test in their study whether resource dependence is among the structural factors (Z^i). Their results showed that for the period 1970 to 1989 natural resource abundance depressed economic growth. Sachs and Warner (1995b) kicked off the econometric evidence of slow economic growth with economic dependence on natural resources. Most researches who support the resource curse theory tend to follow Sachs and Warner's cross-sectional approach (Gylfason et al. 1999; Rodriguez and Sachs 1999; Bulte et al. 2005). However, their approach has been criticized on a number of grounds and has given rise to a number of studies that find a positive or ambiguous relationship between natural resource endowments and economic growth. Some studies shed doubt on the theory of the resource curse, including (Arezki and Van der Ploeg 2007; Alexeev and Conrad 2009; Cavalcanti et al. 2011a; Cavalcanti et al. 2012; Esfahani et al. 2013; Esfahani et al. 2014). Subsequently a number of statistical studies, such as (Delacroix 1977; Davis 1995; Herb 2005), showed no evidence of a curse for resource-rich countries. A number of these studies have questioned this approach and have used other types of regression, namely panel data, vector auto-regression or autoregressive distributed lag, due to their advantages for studying economic growth.

Eltony and Al-Awadi (2001) studied the effect of oil price fluctuations on macroeconomic variables in Kuwait using a VAR model. Their results illustrated that oil shocks are an essential factor in explaining fluctuations in macroeconomic variables in Kuwait. They found evidence of the effect of oil price fluctuations on government expenditure. Raguindin and Reyes (2005) studied the impact of oil price fluctuations on Philippine macroeconomic variables from 1981 to 2003. They found evidence that an oil shock will lead to a long decline in the real GDP. Interestingly, their asymmetric VAR framework showed that oil price reductions had a greater effect on each macroeconomic variable's fluctuation than oil price surges.

Alexeev and Conrad (2009) illustrated that the adverse impact of an abundance of natural resources on institutions is largely because of using initial GDP values as control variables. They stated that it appears that natural resource abundance increases per capita GDP without concurrent development of institutions in the country. They concluded that, for the reason given, and since institutions in nations with natural resources are positively correlated with GDP, the results would be biased towards a negative impact of natural resources on institutions by considering GDP as a control in a regression of the quality of institutions on oil wealth.

El-Anashasy (2006) investigated the effects of oil price fluctuations on Venezuela's economy over the period 1950 to 2001. He used a VAR model to study the link between oil prices, government income, GDP, government consumption and investment. The results indicate a long-term relationship between economic growth and fiscal balance. In addition, he found evidence that oil incomes not only have an effect on long-term economic performance but also create fluctuations in the short run.

Berument et al. (2010) investigated the impact of symmetric oil price shock on industrial production for MENA countries using several VAR models for each country from 1960 to 2003. They found different results for different countries through their impulse response analyses. The results for Iran, Algeria, Iraq, Jordan, Kuwait, Oman, Qatar, Syria, Tunisia and the United Arab Emirates show that oil price fluctuations have a positive and statistically significant impact on their GDP. Although the results for Bahrain, Egypt, Lebanon, Morocco and Yemen were positive, they were not statistically significant.

Olomola and Adejumo (2006) studied the role that oil price shocks played in the output, inflation, real exchange rate and money supply in Nigeria over the period 1970 to 2003 applying a VAR model. Their results indicate that oil price shocks do not affect output and inflation; however, they have a significant impact on both the real exchange rate and money supply in the long term.

Farzanegan and Markwardt (2009) analysed the impact of oil price changes on real GDP per capita, public consumption, imports, the real exchange rate and inflation using the VAR approach. Their findings showed that higher oil prices will lead to appreciation in the real exchange rate. They believe this is one of the syndromes of the Dutch Disease where imports and domestic output per capita increase considerably. Furthermore, government expenditures increase in the mid run.

Leite and Weidmann (1999) did not find any direct effect of natural resource intensity on economic growth from 1970 to 1990; however, they demonstrated a significant indirect impact through the influence of resources on corruption, which negatively influences economic growth. The outcome was confirmed by other works such as Isham et al. (2005) and Sala-i-Martin and Subramanian (2003). They investigated the impact of natural resources on wider indexes of institutional quality and policies. They indicated that for a given level of institutional quality, natural resource intensity has no direct effect on growth. Rather, natural resource endowments show their negative impact indirectly through institutional quality, although this is only the case when resources are geographically concentrated like oil.

Lederman and Maloney (2003), without controlling for institutions, concluded that resource endowments measured by resource export per worker and in ratio to GDP have a positive impact on growth. On the other hand, resource concentration and export dependence have an adverse impact on growth. They believe the negative effect is because of a reduction in the accumulation of both physical and human capital and deterioration of the terms of trade. In another panel study, Torres et al. (2012) illustrated in a single panel estimation with random effects that oil endowments that are measured by production did not hamper economic growth from 1980 to 2003 in oil producing countries.

Lane and Tornell (1996) augmented a neoclassical growth model by substituting powerful groups for the representative household. The model encompasses a different notion, which is called the “voracity effect”. They define it as “a more than proportional increase in redistribution in response to an increase in the raw rate of return” (1996: 213). Their results demonstrated that, in a country with powerful groups and poor institutional quality, the voracity effect only operates if the substitution elasticity is high. In general, it can be said that there is no consensus over the resource curse hypothesis. There is no agreement over the most accurate method of measuring resource abundance and statistical technique for analysing the impact of natural resources.

According to Collier and Laroche (2014), one of the essential measures that needs to take place in resource-rich countries is that of high-quality institutions that are suited to their development path. As they emphasized, since developing countries are on a different development path their needs are different and thus they need institutions that meet their own needs. They suggested that five sets of rules are necessary for resource-rich countries to benefit from their natural resources. The first one is transparency; the second is that governments will be required to specify the amount of asset incomes they dedicate to asset accumulation; the third is that governments must set up a rainy-day rule to guarantee that government expenditure and consumption will not face difficulties; the fourth one is to make sure that investment is contributing to development and economic growth in the long term; and the final rule states that countries should stop borrowing and focus on saving. Only if savings go up can the ‘rainy-day’ rule work.

Ross (2012), drawing on statistical analysis, demonstrates that the oil curse hypothesis is not always true. In chapter six he shows that there is no evidence for oil acting as a curse for economic growth in the long-term, stressing the long-term growth rates between oil rich and oil-scare states for the last fifty years. While he highlights that the economic growth has fluctuated more in oil rich countries he also challenges the findings that have illustrate a reverse association between oil endowments and the quality of institutions on methodological grounds.

Jones Luong and Weinthal (2010) argue in their book that it is not natural resources wealth which created a relatively poor economic performance, but the ownership structure that countries choose to manage their wealth is responsible for the poor outcome. They identify four different types of ownership, and of the four types in which the bulk of the endowments is under, private management is the best. On the other hand the type in which the state displaces both private and foreign investors is the worst. The other types are either a leading role for foreign firms or with a division between private and state management. The last two types fall in between the best and the worse.

3.6 Drawbacks of the Studies

All empirical studies that either confirm or doubt the resource curse hypothesis used econometric approaches. There are a number of grounds on which their econometric approaches to the negative link between resource abundance and economic growth can be questioned. First, the studies do not take into account the time dimension of the data since they mostly rely on cross-sectional methods.

The general trend in the literature for studying the natural resource abundance and economic growth relationship is to use cross-sectional method based on the superiority of the data set. Within a cross-sectional approach, the differences in countries such as the initial level of output per capita, the quality of institutions, the political system and the level of technology have not been considered. In other words, the problem of homogeneity arises. Furthermore, cross-sectional methods are subject to endogeneity problems (Cavalcanti et al. 2011b) and endogeneity, is the main reason for being sceptical about their results. The most common response to the endogeneity[1] problem has been the use of the instrumental variables technique suggested by Anderson and Hsiao (1981). Most panel data studies overcome the endogeneity problem by using homogeneous panel techniques like the traditional fixed- and random-effects estimators, which usually use an instrumental variable technique and generalized methods of moments estimators. A wide range of instrumental variables has been proposed, so one can find an instrument that is correlated with the endogenous explanatory variable. As Durlauf et al. (2005) indicated in their study, it is not easy to identify valid instrumental variables. Discussion about instrumental variables raises another significant although neglected problem in empirical research on economic growth, and that is the association between model specification and instrumental variable selection. It

[1] It should be borne in mind that there may be different reasons for the correlation between the residuals and an explanatory variable, such as omitted variables and measurement.

is not possible to discuss the validity of instrumental variables without referring to the choice of the specific growth determinants.

Despite the fact that with homogeneous panel data frameworks the intercept can be diverse among countries, other parameters are assumed to be identical; consequently, the model suffers from a high degree of homogeneity. In addition, a cross-sectional growth regression augmented with the ratio of primary-product exports to GDP suffers from endogeneity of explanatory variable issues. Lederman and Maloney (2002) tested Sachs and Warner's hypothesis but they allowed for endogeneity and used different periods of time, and their outcome did not confirm Sachs and Warner's results. Furthermore, in the same line of research, Arezki and Van der Ploeg (2007) used instrumental variable techniques to overcome the endogeneity problem of explanatory variables. By controlling for institutional quality, openness and initial income, Sachs and Warner's findings did not survive.

The other pitfall of the cross-sectional approach is that it suffers from omitted variables since it overestimates the impact of initial output per capita and as a result underestimates the speed of conditional convergence. The standard method to overcome the problem of omitted variables is to use proxies or instruments; however, this methodology makes strong assumptions that are usually not met in reality. An alternative is to use the application of non-stochastic weighting suggested by Robinson (1991), which is a form of sample splitting or random weighting considered by Hidalgo (1992), or a random search procedure proposed by Gozalo (1993). The omitted variable is a serious model misspecification, and all the mentioned methods can only alleviate the problem, not resolve it. Although it can be argued that the difficulty that arises from the omitted variables problem applies to historical and case studies, it is expected that the researcher has an understanding of important forces, which are difficult to quantify.

Another drawback of this approach is that the cross-sectional approach does not take into account the time dimension of data. Moreover, as mentioned earlier, Cavalcanti et al. (2011b) argued that most existing work concentrates on the impact of resource endowments on the economic growth rate, while most growth frameworks based on the Solow/Ramsey theory indicate that the impact on growth should be temporary but could be forever for the level of per capita income. This is in line with the empirical results provided in the work by Klenow and Rodriguez-Clare (1997). In addition, the studies that found a negative association between natural resources and economic growth usually looked at the time span of 1960-2000.

To address these drawbacks, different researchers used different approaches. Some used panel data approaches, such as (Cavalcanti et al. 2011b), and their results were in contrast with the standard resource curse and economic growth literature. Their outcome sheds doubts on the robustness of Sachs and Warner's and their followers' results. One alternative, as mentioned earlier for studies looking at a number of countries, is the use of panel data, which increases the efficiency, and also richer models can be estimated; however, it could create biases if the parameter homogeneity assumptions are not correct. The ultimate advantage of a panel data approach over a cross section is that it makes it possible for a researcher to have flexibility in taking into account differences across countries.

Some other scholars, such as (Luintel and Khan 1999; Garratt et al. 2003; Dritsakis et al. 2006; Mahadevan and Asafu-Adjaye 2007; Uğur 2008; Esfahani et al. 2013;

Mohaddes and Pesaran 2013; Esfahani et al. 2014) among others, used vector error correction models, and followed this approach by estimating a regression as follows:

$$y_t = \beta_{y0} + \beta_{yy1} y_{t-1} + \cdots + \beta_{yyp} y_{t-p} + \beta_{yx1} x_{t-1} + \cdots + \beta_{yxp} x_{t-p} + v_t^y \qquad (3.2)$$

where y_t is the natural logarithm of per capita output (economic growth), β_{y0} is intercept coefficients at lag p, v_t^y is the stochastic term or the error term at time t and x is the matrix of other variables. Exogenous variables can easily be added to the right-hand side of the VAR equations, without including any additional equation in the model. The VAR approach is suitable due to its ability to avoid imposing strong restrictions and its ability to consider the dynamic structure of the framework. Another advantage of VAR frameworks over traditional large-scale macro-econometric models is that the outcome is easily interpretable.

Different studies have used different proxies to measure resource abundance. The most popular measure of resource abundance is the share of resources in either export or GDP following Sachs and Warner (1995b). However, the share of resources in export expresses resource dependence rather than resource abundance, which was pointed out by Brunnschweiler and Bulte (2008). Brunnschweiler (2008) and Brunnschweiler and Bulte (2008), using resource stocks data from the World Bank, illustrate that resource abundance does not have negative impact on growth. However, Van der Ploeg and Poelhekke (2010) believe this effect is not significant after accounting for a number of statistical issues (although they say that not taking into account the volatility channel might lead to the conclusion that there is no impact from natural resources on growth).

Wright and Czelusta (2004) differentiate between natural resource endowments and export dependence. Ding and Field (2005) claim that while resource abundance cannot be a curse for a country, natural resource export dependence can be. Then they run a recursive framework and demonstrate that the negative impact of natural resource export dependence and abundance fades. They find an inverse correlation between human capital and export dependence and claim that the curse may be because of the level of dependence on resources, which is the result of poor development of human capital.

3.7 Successful Management of Natural Resources

There is evidence that some countries have been very successful in using their natural resources. One important factor in successful stories on natural resources is high-quality institutions, which can turn natural resources into an asset rather than a challenge. In states with good institutions such as decent protection of property rights, a sound tax system and the rule of law, natural resources have a very significant positive impact on growth. In general, more natural resources can provide the private sector with sufficient investment opportunities, in turn generating positive externalities for other sectors. The importance of institutional quality has already been discussed.

Improving other sectors along with natural resources export is another key factor for successful management of natural resource endowments. For instance, in Norway most of the oil resources are found offshore, which requires high-technology equipment to extract. In the initial extraction phase in 1973, Norway was dependent on foreigner companies, but very soon after the first phase the country developed its own industry and created a world-leading industry for offshore extraction. This means Norway was able to export its human capital, technology and physical capital for oil extraction to countries with offshore resources. In other words, this was in contrast to the so-called Dutch Disease explanation, in which it is believed that the main economic reason for the resource curse in resource-rich countries is the crowding out of non-oil exports.

One way of managing earnings from oil is to ensure that oil incomes are put aside into a national saving fund in high-price periods (Davis et al. 2001; Davis et al. 2003a; Davis et al. 2003b). Many resource-rich countries have established commodity funds for investing their earnings in boom times, usually in international portfolios. The first and largest commodity funds are in the Persian Gulf, owned by Kuwait and the United Arab Emirates (Frankel 2010). It has been argued in the literature that the establishment of a commodity fund does not automatically do anything special to ensure that political elite will not spend when it is flush (Davis et al. 2003a; Humphreys and Sandbu 2007).

To make sure the funds are used for enhancing economic growth, they should be used transparently with clear instructions that politicians should not intervene with the aim of maximizing the financial well-being of the country. The Norwegian State Petroleum Fund (Norwegian Pension Fund) is usually used as a model (Holmøy 2009). In essence, Norway's legal system places a number of limitations on what policymakers are allowed to do, and the money is used with political aims that go unnoticed when held up as an example for developing countries to follow[1].

The Norwegian Petroleum Fund was established in 1990 with the logic that the return on extraction of oil is greater than the return on leaving it as reserves. Not surprisingly, in 2008 the total value of the Norwegian Petroleum Fund was 400 billion US dollars, which made it the largest sovereign oil fund in the world. It is worth mentioning that the oil fund is successful in Norway because it is under public scrutiny and a group of independent economists always make the decisions concerning it. In addition, everything about the Norwegian Petroleum Fund is very transparent. Iran, another oil-rich country, established the Oil Stabilization Fund (OSF) in 1999, which was a government-controlled sovereign fund. Unlike the Norwegian fund, the OSF was highly secretive and the decisions were made by politicians rather than economists. The OSF did not last long because the new government in 2004 decided to abolish it.

According to Amuzegar (2005), there are three fundamental reasons for creating an oil stabilization fund. First, it is essential to remove, or at least decrease, the expense of stop-go public expenditures related to the ups and downs of oil prices in the international market. The second aim is to maintain fiscal discipline through decoupling government expenditure from oil price fluctuation; therefore, plans on public spending would not be changed by the behaviour of oil prices. Finally, one objective is to circumvent extreme appreciation and depreciation of the national

[1] The political objectives are thought of as social responsibility. "Norway Proposes to Do Well in Its Investments by Doing Good", *New York Times*, May 4, 2007, p. C4.

currency as a result of fluctuation in oil rents, which can be prevented by an oil stabilization fund.

Alesina and Rodrik (1994) believe that equality in the society and minimal government intervention are the key reasons for managing resources successfully. However, Acemoglu et al. (2002) challenges this view with the case of Botswana, which is successful in turning its resources into a blessing but both inequality and government invention are significant. Therefore, he concludes that what lies behind the success in Botswana is high-quality institutions and a good political system. In general, it can be said that to manage natural resources well, a number of factors are important, including appropriate policy implications, high-quality institutions and a fund to distribute wealth among different generations.

3.8 Conclusion

The effects of natural resources on economic performance are by no means universal. Economic growth is determined by several and different factors across countries. Furthermore, growth factors are interrelated in multidimensional ways, creating a specific case in each country. This point has essential implications for the methods that should be used for studying growth and also for the consequences in each country. Broadly speaking, natural resource endowments do not necessarily lead to poor economic performance; it is best to consider this as a double-edged sword. Theoretical reasoning and statistical evidence show that natural resource endowments can have both negative and positive effects on economic performance.

Institutions and policies have significant roles; therefore, they have to be tailored to each country’s circumstances. By bringing together a number of analytical perspectives, the evidence illustrates that natural resources are not a curse. In other words, empirical and historical studies demonstrate that natural resource endowments do promote economic growth and development when combined with knowledge regarding innovation, good policies and high-quality institutions. Without doubt, institutions and policies are different in every country due to the local circumstances. However, with innovation and the right policies, there is no reason for resource-rich countries to face a curse.

Oil income can offer a way out of the poverty trap. It is essential to use oil revenue on public goods, which act as the platform for private investment, development and economic growth. When in boom times petrodollars are invested in different public goods, the result is that private investment and economic activities will lead to higher income, better budgetary resources, involving non-oil earnings, and consequently more opportunities to fund public goods through a general increase in economic activities. If for any reason oil earnings decline, a strengthened private sector should manage to offset this (Humphreys et al. 2007).

This chapter suggests that although the resource curse literature is far from reaching a consensus, it has been progressing, particularly in the estimation approaches; therefore, it is getting closer to offering a precise and complete response to the resource curse theory. A different result, which arises from applying a variety of measurements for resource abundance, and empirical methods offer a number of hints to answer the hypothesis. It should be mentioned at the same time that it is more difficult to compare different answers in order to find a united cohesive response. In general, policies, institutional quality and volatility seem to be the most reasonable explanation of the role that natural resources play in a country.

Appendix 3

Table (3.1) Summary of Studies on the Impact of Natural Resource Abundance on Economic Performance

Study	Natural resource measurement	Period / channels of transmission	Econometric Method	Findings
Auty (1993)			Descriptive	Resource curse
Gelb (1988)			Descriptive	Resource curse
Sachs and Warner (1995, 1997, 1999, 2001)	Ratio of natural resource export to GDP	1970-1990 Looking at economic growth	Cross-sectional	Inverse association between natural resource export and economic growth

Gylfason (2001)	Natural capital in national wealth	1970-1998 Human capital	Regression analysis	Natural resources crowd out human capital; therefore lower economic growth
Gylfason (2006)	Natural resource intensity, which means the extent to which a country depends on its natural resources	1960-2000	Cross-country evidence	Natural resources crowd out foreign capital, social capital, human capital, physical capital and financial capital; therefore lower economic growth
Gylfason and Zoega (2006)	Share of natural capital in national wealth	1965-1998	Regression analysis	Relying on natural resources reduces saving and investment thereby lowering the level of consumption and output per capita
Mehlum et al. (2006)	% of GDP as natural resource export	1965-1990 Institution	Cross-sectional	Institutions are decisive on the resource curse, resource curse exists in countries with inferior institutions

Kim and Lin (2015)	Primary product exports	1990-2012	Heterogeneous panel co-integration techniques	Natural resource abundance exerts a negative effect on per capita income
Mehara (2009)	Oil income	5-year average data over the period 1965-2005	Panel study	Negative effects of oil revenues are not universal but appear only over the ‘‘threshold’’ level of oil revenues
Berument et al. (2010)	Oil price shocks effect	1952-2005	Structural vector autoregression	Shock in oil prices has a statistically significant and positive effect on economic growth
James (2014)	The value of crude oil and natural gas production relative to GDP	1970-1990	Cross-sectional	Positive relationship between resource dependence and economic growth in 1970s and negative in 1980s, however in general positive relationship
Boyce and Emery (2010)	Natural resource export	1970-2001	Panel data	Resource abundance is negatively correlated with growth rates but positively correlated with income levels

Brunnschweiler (2008)	Per capita mineral and total natural resource wealth	1970-2000	OLS & 2SLS	Positive direct empirical relationship between natural resource abundance and economic growth
Alexeev and Conrad (2009)	Logarithm of 1993 hydrocarbon deposits per capita / logarithm of 1 plus the country's per capita production of oil in 2000	1965-1970	2SLS estimations	Positive impact of natural resources on growth
Yang and Lam (2007)	Real oil prices from BP	1960-2002	Co-integration analysis	They find oil booms lead to lower GDP or less investment in only three countries out of 17

Chapter Four

THE OUTLOOK OF THE IRANIAN ECONOMY

"Where oil is first found is in the minds of men"

Wallace Pratt

4.1 Introduction

There is a widespread belief that countries without oil or any kind of natural resources are better off than countries with natural resources. Even across countries with natural resources the impact of these resources is not the same. How did some governments use their income from natural resources in a way that led to economic prosperity? The answer lies not only in how countries spend the money from oil revenues but also in the quality of institutions, politics, culture and social norms. Yet there is no consensus on the role that oil can play in the economy, so it is worth exploring this topic further.

The aim of this chapter is to weave seamlessly together the two related themes of the history of oil and the economic growth of Iran. Remarkable chunks of government income in Iran are obtained from non-tax income – to be specific, in the form of oil receipts. Iran has not been successful in developing the private sector and a sound tax system. It might broadly be said that in developing oil exporting countries, there have been widespread failures in oil revenue management leading to poor economic performance and sluggish economic growth.

This chapter proposes an overall view of the history of the Iranian economy focusing on oil. In addition, it collectively lays out a broad framework for thinking about different issues in regard to oil endowments and their impact on the Iranian economy. In doing so, the discovery of oil, the history of oil production, development plans and the general performance of the Iranian economy will be discussed. Loosely speaking, the history of the Iranian economy can be divided into two main periods, i.e. before the Islamic revolution and after the revolution. Needless to say, in both periods oil has been the cornerstone of the Iranian economy. Nevertheless, because of the importance of oil to industrialized countries, the decision-making on oil has never been purely economic. Therefore, in analysing the role that oil has played, the political economy of the country needs to be considered as well.

The general aim here is to examine the macroeconomic performance and policies in Iran over the time span of 1955 to 2014. The documentation of Iran's development indicates that Iran was transformed from a farming-based economy in the 1960s to almost a modern economy in the 1970s by alterations in the traditional sectors. Iran is a large resource-rich country that has experienced a number of important events in the course of this study, including oil booms and busts, revolution, sweeping institutional changes, an eight-year war with her neighbour Iraq and severe economic sanctions.

The following sections will examine the role of oil incomes in the Iranian economy from the time it was discovered until 2014. In addition, the following pages incorporate efforts to explain the role that oil has played in the Iranian economy, while looking, furthermore, at different channels through which oil income can impact on the economy. Studies have usually focused on the short-term impact of having oil and have generally eschewed the long-run impact. Therefore, this work looks at the role of oil historically over the long-term. Needless to say, the role of oil revenue as a key factor in enhancing economic development derives not only from its direct effect on the economic framework but also more significantly from its pervasive influence on social life, politics and culture. This study considers all relevant channels that could affect the economy of Iran through oil endowments. In addition, it will provide a detailed picture of the economic structure of Iran over the course of the study.

The structure of the chapter is as follows. Following this introduction, Section 4.2 starts with the history and development of the oil industry in Iran. Section 4.3 talks about the development plans in Iran starting from 1946, and this is followed by Section 4.4, which analyses the macroeconomic performance of the country before the revolution. The subsequent section goes to the second period of the study and focuses on the changes after the revolution, which is followed by analysing the development plans after the revolution. Section 4.5 briefly analyses the brief experience of the Oil Stabilization Fund. Finally, Section 4.6 provides a summary and some concluding remarks regarding Iran’s economic performance.

4.2 The Iranian State and the History of Oil

For the years before 1908, oil did not exist in the Iranian economy, and even after its discovery, for a long time oil did not have a significant role in the economy since Iran’s share from oil profit was insignificant. On the one hand, in the late nineteenth century, Iran internally under the Qajar dynasty was in economic disarray. On the other hand, from the outside, in the north, Iran was surrounded by the Tsarist empire and in the east by Britain. Hence, the country did not have clear rules and regulations, and also Iran’s Shah had a fragmented authority and to earn some money he agreed on different concessions. As a result, Britain and Russia were competing over Iran and it can be concluded that Britain won.

The story of oil in Iran started in 1901 when William Knox D’Arcy, an Englishman, singed a concession with Muzafaro-Din Shah, the king of Iran. British agents supported D’Arcy in the Shah’s court and outmanoeuvred Russian objections; also, a few countries were bribed in return for supporting Britain. According to this agreement, D’Arcy was given rights to explore, develop and produce any oil fields in almost three-quarters of Iran for 60 years. In return, the king of Iran accepted payment of £20,000 in cash and 16 per cent of net annual profit (Article 10 of the D’Arcy Concession). In 1901, exploration for oil began in the west of Iran led by D’Arcy. However, after almost two years there were only two wells producing 25 barrels a day, which was an insignificant quantity in terms of commercial production. Later, the exploration moved to the southern part of Iran in order to get closer to export facilities. Although, during this time, oil was discovered, on the one hand, the extent of the discovery was not commercially significant, and on the other, D’Arcy was running out of money for continuing this oil exploration.

In 1905, he found another source of finance by selling the majority of his rights to the Burmah Oil Company. The endeavour to find oil continued and a large number of oil well tests took place. In 1908, the cost of searching for oil rose to half a million pounds without any successful results. Therefore, the British government decided to shut down the exploration in Iran. However, George Reynolds, the chief explorer in Iran, decided to continue operation until the order was confirmed by post. Luckily enough, before the letter reached Reynolds (the geologist who had been hired by

D'Arcy), oil was found in commercial amounts in Masjid-i-Suleiman (a city in the south of Iran) on 26 May 1908. This new discovery led to the establishment of a new corporation, which was called the Anglo Persian Oil Company (APOC), in London with an initial capital of two million pounds.

By 1913, one of the biggest refineries had been built in Abadan (a city in the south of Iran) and export of crude oil started shortly after. At the same time, the British government, during Churchill's time, injected two million pounds into the company and as a result acquired 51 per cent of the total shares. Consequently all oil production in Iran was controlled by the British government. Later on, when Churchill decided to run the British naval fleets on oil, the demand for Iranian oil increased dramatically. Therefore, oil production increased significantly during the First World War. Oil production in Iran, which had been 5,000 barrels per day in 1913, increased to 33,000 in 1920, and by 1929 it had reached over 115,000 barrels a day. However, most of the demand for Iranian oil was from the Royal Navy, which received a significant discount rate.

"The formation of the Anglo Persian Oil Company (APOC) in 1909 and first production in 1912 was a major factor in the British Admiralty deciding to switch from coal to oil on the eve of the First World War. Also because Winston Churchill as First Lord of the Admiralty wanted Britain to own directly at least part of the nation's oil needs, this led to the purchase of a British government stake in APOC. For the time being Iran just happened to be the country where the oil was discovered, and was treated as little more than an ignorant, but important, shareholder who had to be humoured from time to time."

(Graham 1979: 43)

In the first 40 years after discovering oil the Iranian governments received only 14 per cent of the income (Mirjalili 1993). In the words of Emami:

“By the end of the 1950s, after nearly half a century, it was estimated that the oil industry provided Iran with 450 million dollars (9 per cent of total profit) in cash and helped to build three major ports, 2500 kilometres of roads, a few thousand houses and a number of hospitals. In addition, the oil industry employed an average of about 25,000 Iranians (3,500 non-Iranians) for mostly unskilled jobs. By contrast, during the same period the British government received $1,680 million in taxes, and British stockholders received $670 million, limited to an initial investment of $4,200,000.”

(Emami 1980: 12)

Although oil production increased 23 times between 1914 and 1929, royalties to the Iranian government according to the D’Arcy Concession amounted to only 16 per cent of net profit. In other words, royalties were increased less than fivefold. Given the significant surge in oil production and rising profit of APOC, the share of Iran from this profit was questioned by the king of Iran, Reza Shah (Kinzer 2003). It is important to mention that the income from APOC never surpassed 19 per cent of the total income of the Iranian government before 1929 (Ferrier and Bamberg 1982). Furthermore, between 1914 and 1924, the taxes that the company paid to the British government exceeded the royalties paid to Iran; however, from 1924 to 1929 the royalties were marginally larger than the taxes paid by the company to the British government (Mohaddes and Pesaran 2013).

As mentioned earlier, APOC’s main customer was the British government, and in 1914, Britain demanded that 6 million tons of oil fuel should be provided to the British Admiralty over the course of 20 years. As a result, the Royal Navy, during the First World War, received 66 to 69 per cent of AOPC’s total refined oil; however, even after the First World War, in 1919 and 1920, APOC supplied 53 per cent of its total production to the Royal Navy (Ferrier and Bamberg 1982). According to the D’Arcy Concession, the oil was supplied to the Royal Navy by APOC at discount; therefore, the profit from the cooperation was more significant than the taxes paid by the Iranian government.

Between 1928 and 1932, the Shah of Iran raised concerns about the royalties that Iran used to receive. Hence, after negotiations between the Iranian government and APOC, the British government started to revise the D’Arcy Concession and eventually Reza Shah (the king of Iran) cancelled the concession in 1932. Nevertheless, a new concession was signed in 1933; the new agreement extended D’Arcy’s Concession, which was supposed to expire in 1961, to the end of 1993. In addition, 80 per cent of the total area granted for exploration and extraction in D’Arcy’s Concession was reduced. However, APOC was allowed to decide on 100,000 square miles to keep for exploration (Bamberg 1994).

The most important change in the new agreement was that royalties were based on actual production of oil rather than profits. The new calculation of royalties led to a significant surge in the Iranian oil revenue between 1930 and 1950, with oil production increasing from 126,000 to 648,000 barrels a day. Yet, British taxes between 1940 and 1950 were more than twice more than Iranian royalties. Although oil had been produced in commercial amounts since 1908 in Iran and the oil industry was developing significantly, only a very small amount of money from oil was used for development of the country. Regardless of the steady rise in the production of oil, a fixed proportion, which was 10 per cent (£120 million), was given to the Iranian government in the form of royalties, taxes and share of profits from 1911 to 1951.

During the period 1911-1919 the royalties that the government received amounted to £335,000, which increased to £10.5 million during the 1920s. During the 1930s, due to the worldwide depression, the positive impact of the 1933 agreement ceased to be felt; therefore, the royalties received by the government of £26.9 million were lower than the expected amount. Due to the fragmentary character of data on the budget of Iran, it is very difficult to evaluate the exact role of oil income in the government budget. Nonetheless, based on the available data, rough assessments can be made. Up until 1927, oil receipts were mainly spent on current expenditures. This period was followed by World War II, and a significant decrease in development expenditures because of the inflation caused by the war. It can be concluded that from 1910 to 1949, the contribution of oil incomes to the total government income did not exceed 13 per cent.

By 1950, Iran was the fourth-largest oil producing country in the world. The Anglo Persian Oil Company was renamed the Anglo Iranian Oil Company by Reza Shah. In March 1951, after a series of disagreements between the AIOC and the Iranian state, followed by political intervention by Britain in Iranian domestic affairs and a rise in the interest in nationalism, oil was nationalized by the Majlis, and Mohammad Mosaddegh, who masterminded this action, became Prime Minister. Through this action the AIOC started protesting, which was backed by the British government. Because of the rejection of the AIOC's objection by the Iranian government, the AIOC started proceedings against Iran in the International Court of Justice in The Hague. In fact, the British government's claim was that Iran had acted one-sidedly by nationalizing its oil and breaking its deal with the AIOC. However, the international court, on 22 July 1952, supported Iran's position. Following Mosaddegh's arrival in office, Iran's oil was controlled by the National Iranian Oil Company (NIOC).

There are a number of factors that can be considered reasons behind the nationalization of oil. First, after World War II the oil industry in the world became a very important sector. Second, with the development plans in 1949 a reliable source of exchange rate was needed and incomes from oil revenues were a good source. It is worth mentioning that the Iranian government rejected the request to grant oil concessions to Russia in the north of the country. The nationalization of oil led to a significant reduction in oil production and consequently government income. The Iranian government reacted by encouraging non-oil exports, and bonds were issued to meet financial requirements.

Consequently, oil imports decreased from 6.2 billion rials in 1950 to 5.3 billion rials in 1953, whereas non-oil exports increased from 3.49 billion rials to 8.3 billion rials over three years. In 1952 and 1953, Iran was able to produce only 4 per cent of the level of oil production that had been reached in 1950. The reaction of Britain to oil nationalization was an economic boycott on oil production and oil export from Iran. As a result, the oil income dropped from $400 million in 1950 to $1.85 million in 1953 (Emami 1980). Although the reduction in production was because of the lack of technical skills since British personnel had left Iran, the key reason for the fall in production was the embargo on the Iranian oil by Britain.

Mosaddegh was removed in August 1953 by a coup organized by the CIA and backed by Britain when the negotiations between the Iranian and British governments did not reach an outcome in favour of the British government. A new round of negotiations took place between the new Prime Minister, Fazlollah Zahedi, the British government and the American government. The result was the 1954 Consortium Agreement, which allowed eight European and American companies to extract petroleum from the 100,000 square mile area covered by the 1933 concession. In return for $1000 million dollars, the Anglo-Iranian company turned its share over to the new established consortium. It was agreed that the $1000 million dollars would be paid in instalments by the members of the consortium and 25 million pounds by the Iranian government over ten years. In accordance with the new agreement, the AIOC agreed and turned over its possessions in Iran to the newly established NIOC. In return, the Iranian government agreed to pay a net amount of 76 million pounds over a period of ten years.

The shares of the consortium were allocated as follows: 40 per cent of the shares belonged to British Petroleum (BP), 14 per cent to Royal Dutch Shell, 6 per cent to the Compagnie française des pétroles (CFP) and the rest (40 per cent) was shared equally between five American companies (Exxon, Gulf Oil, Mobil, Socony and Standard Oil of California). Based on the new agreement, the profit would be shared between Iran and the consortium members on a 50-50 basis. Oil production increased to 353,000 barrels a day by the end of 1955, and by 1959 it was 951,000 barrels a day; this level of production was 50 per cent above the level in the pre-nationalization period.

In line with the new oil law in 1957, the NIOC agreed on three joint-venture contracts with independent international companies in order to explore the areas that were not included in the consortium. The companies were the Italian company AGIP Mineralia, the Pan American Petroleum Corporation and a Canadian company, Sapphire Petroleum Limited. However, the agreement with the Canadian company, due to the lack of progress in oil exploration, was abandoned. The new agreements were quite similar to the pervious consortium, the period for all of them was 25 years and there was a 75-25 per cent division of the net profits in favour of the Iranian government.

According to the new agreements, all exploration costs would be borne by the foreign companies, hence the failure of any of them to obtain a commercial level of oil would not create any problems for the NIOC. The new-style agreement of Iran was followed by a number of other Middle Eastern oil exporting countries. In essence, this played an important role in the foundation of the Organization of Petroleum Exporting Countries (OPEC). These kinds of agreements paved the way for a kind of agreement whereby the oil income of countries is based on oil prices rather than quantity. As a result, the price of oil started to play a significant role in the international oil market.

In 1979, the Islamic revolution happened and the system by which oil revenues were managed changed dramatically. The policy on exports and oil production after the revolution was to balance government income and its expenditure. The initial step was terminating the consortium’s role in oil production and also ending its advantaged position as the main customer of Iranian oil. The preference of the Iranian state ever since the revolution has been for government to government contracts. The government in Iran, like all other Middle Eastern major oil exporting countries, has acquired all oil export earnings since the revolution. The earnings from oil always go to the Central Bank and the government account is credited, and thus foreign reserves increase.

4.3 Development Plans in Iran

An important phase in the economic development of Iran started with development plans in the period 1946-1979. The story of Iran's economic development plans started in April 1946 when the Iranian government established an Organization of Development Planning and hired a foreign firm located in San Francisco for consultation. The history of development plans can be divided into pre-revolution (1949-1978) and post-revolution (1978-2014) periods.

In 1946, the First Development Plan was drafted and presented three years later to the cabinet; it was a seven-year plan for reconstruction and development. The proposed budget for the first plan was 21 billion rials. The first development was broken down into different sectors, including agriculture, roads, railways, ports, airports, industry and mines, communications and social projects (Amuzegar and Fekrat 1971). The main source of finance for the first plan was oil income, which provided one-third of government expenditure in the 1940s. Therefore, the government started negotiations with the AIOC for higher royalty payments. However, oil nationalization in 1951 caused a severe cut in the oil revenues of Iran. As a result of the sharp decrease in oil revenue, the First Development Plan was crippled. At the same time, the Iranian economy faced financial difficulty, which made it even more difficult to get credit from alternative sources. The resumption of the oil consortium and the rise in oil income made the Plan Organization active again. In the last remaining years of the First Plan, a number of short-term "impact projects" were prepared and were supposed to be implemented. In the meantime, a new planning board was prepared to review the First Plan and prepare a new plan for another seven-year period. Since during the First Development Plan period (1949-

1955) the oil production was ominously disturbed, the effects on the Iranian economy were damaging.

The Second Plan was organized for another seven-year period from 1955 to 1962 with a budget of $933 million. A quarter of this money was supposed to be used for projects that started in the First Plan but were not finished. However, the budget was increased by 20 per cent almost a year later. The budget was supposed to be allocated to different sectors in the country as follows: 29.88 per cent to agriculture and irrigation, 40.48 per cent to transport and the rest to social services. Again the main source of financing the Second Development Plan was oil income. It was agreed initially that almost 80 per cent of the revenue from oil should be used for development expenditure annually. However, due to special circumstances, such as an increase in the current public expenditure and a decrease in foreign financial aid, the share of the Plan Organization decreased to 60 per cent at first and then to 55 per cent.

The Third Plan was proposed, with a budget of 190 billion rials, for the period 1962-1967. However, the change in the budget did not stay the same and decreased first to 145 billion, and then increased, first to 200 and then to 230 billion rials. Once again the income from oil was supposed to finance over 74 per cent of the development plan. This time the plan was implemented relatively irregularly. For instance, in agriculture, due to a difficult winter and low private investment, the rate of growth decreased from 4 per cent, which was planned, to 2.8 per cent annually. On the other hand, the industrial sector, unlike its unimpressive beginning at the end of the Third Plan, was growing at the rate of 12.7 per cent per year. In the industry sector new industries received the most significant share of distributions, such as the manufacturing of petrochemical products. The steel industry, which started in the Third Plan, was carried over to the next plan. The steel and petrochemical industries contributed most significantly to the enlargement of the oil industry. Other sectors, such as transport and communication and road building, flourished as well.

The Fourth Plan was launched for the period 1968-1973 with the key objective of increasing the real GNP by 9.3 per cent annually. The general aims of the Fourth Plan were: i) heavy industrialization in a number of sectors such as steel, aluminium, copper and petrochemicals; ii) expansion of water resources; iii) development of the power supply and national rail system; iv) consumption and export of natural gas; v) improvement of rural and urban areas; vi) becoming as self-sufficient as possible in terms of food and raw materials; vii) expansion and diversification of exports; and viii) progression towards modernization (Plan organization 1968).

The Fifth Plan was proposed for the period 1973-1978 and had very ambitious targets compared to the previous development plans. Its initial cost was estimated at 32 billion dollars, which was roughly three times higher than the budget for the Fourth Plan. This time it was expected that oil income would finance almost half of the cost, which was about 17 billion dollars. As a result of severe alterations in the international oil market, the seemingly ambitious targets of the Fifth Plan turned out not to be too ambitious after all. Unlike the previous development plans, the Fifth Plan did not face any financial constraint owing to the two subsequent unprecedented price spikes in the international oil market. Nevertheless, there were other bottlenecks such as a lack of human capital, inadequate infrastructural facilities and even a lack of some raw materials (Plan and Budget Organization 1975). The budget of the revised Fifth Plan was almost 122.8 billion dollars, of which about 80 per cent was financed from oil and gas revenues. However, the revised Fifth Plan called for consideration in terms of both qualitative and quantitative aims. The most prominent quantitative target of the plan was reaching the annual economic growth rate of 25.9 per cent.

During the Fifth Plan the country witnessed improvements in different sectors, such as higher national income, higher standards of living, and a better social welfare and socio-economic environment. Although the Fifth Plan created an improvement in industrial sectors and paved the way for economic development, it was not successful in controlling inflation. Therefore, the fast economic development along with the existing bottlenecks of a lack of human capital and high inflation in the already overheated economy shed some doubt on the outcome of the Plan. With the first oil shock in 1973, the oil income of the country increased dramatically. The government had two options for spending the money from oil – one option was to increase its expenditure and the other option was to adjust expenditure in line with the capacity of the economy, and the government chose the former. Ever since then, oil has been an inevitable source of government budgeting. Due to this government policy, high inflation became a new challenge in the country. Nonetheless, inflation was not the only problem that the country was facing in regard to prices. As Bahmani-Oskooee (1996) said, the enormous devaluation of the Iranian currency was translated into a new problem for the economy: “stagflation”. This phenomenon unbalances the economy since depreciation in the value of the currency on the one hand increases aggregate demand and on the other hand reduces aggregate supply as a result of more expensive imports.

No sector in the Iranian economy managed to avoid the adverse effects of high inflation. For instance, housing and construction were the first sectors to suffer and subsequently problems spread to other sectors. The government tried anti-inflationary policies, but it was quite late and also some of them were inappropriate. Therefore, there was no adequate measure to combat the soaring prices. The result was dissatisfaction, not only for rural migrants but also for industrial and rich groups. All in all, the consequence of people's dissatisfaction was an alliance between the Bazaar, the clergy and the intelligentsia in 1978 and the revolution in 1979. Needless to say, the roots of the Islamic revolution can be traced back to the economic activities in 1973-1974 when the NIOC took over the consortium, followed by inappropriate responses of the government to unprecedented oil price hikes.

4.4 The Role of Oil in Development before the Islamic Revolution

This section investigates the direct and indirect influence of the oil industry on the Iranian economy before the revolution. By direct influence we mean the outcome from the direct contact of foreign industry with domestic sectors of the country. On the other hand, indirect effects are those that provide financial assistance for the government like royalties, taxes and income, which can speed up the growth and development process. In the pre-nationalization oil period, this industry went through constant progress and increased production; however, only a small proportion of oil production was used for the development of the country. By 1950, Iran was the fourth-largest oil producing state in the world. However, regardless of the steady rise in her oil production, Iran's share of the money remained constant at about 120 million pounds up until 1951. One of the factors that had adverse effects on the oil revenue of the Iranian government was the discount prices that the British Admiralty used to obtain oil. It has been estimated that Britain saved $500 million in the first 50 years of APOC.

There should be no doubt that Iran owes both her significant rate of growth and economic development during the period 1960-1977 to her oil revenues. In regard to indirect effects of oil export, the oil industry has rescued Iran from any foreign exchange limitations for her development plans. It can even be said that the implementation of all development plans, particularly the last three, was only made possible by the income from oil. More than 66 per cent of the Third Plan, almost 63 per cent of the Fourth Plan and about 80 per cent of the Fifth Plan were financed by petrodollars. In other words, since the capital-absorbing capacity of the economy had developed and there were other sources of income for government expenditure, it was possible to use oil income for economic development purposes.

In terms of stimulating the industrial sector in Iran, oil again played a significant role. It can be said that from 1965 to 1975 an immense industrialization was initiated. The very first endeavour to modernize industry began in the period 1934-1939, which was during Reza Shah's industrial promotion campaign. It happened after the increase in oil income in 1933 and before the war. In fact, between 1934 and 1940 almost 200 industrial plants were in operation. These industries were producing sugar, textiles and matches. The most significant changes in the structure of industrialization happened during the 1960s. The fundamental change was the formation of a small manufacturing sector making consumer goods for local markets. Not surprisingly, the very first heavy industry in Iran was in the fields of oil and petrochemicals. Iran managed to be self-sufficient in some capital and consumer goods. In addition, the policy of heavy industry based on import substitution was quite successful. For instance, the production of refrigerators surged from 147,000 units in 1969 to almost 421,000 in 1975. As a result, the domestic demand was met and the surplus was exported. The same thing can be said about other household durable goods such as water heaters, televisions, air conditioners and gas stoves.

Due to the fragmentary nature of Iran's budget figures for the aforementioned period and the unavailability of data on government income, it is very difficult to assess the influence of oil income on economic performance precisely. Nevertheless, based on the existing evidence it can be said that up until 1927 the money from oil was spent on current expenditures. In the 1930s, the income from oil played a part in development expenditures. However, the period after World War II was characterized by a substantial decrease in development costs, due to inflation caused by war. These expenditures dropped from 30-40 per cent during the 1930s to almost 18 per cent in 1940. They even fell to 12 per cent in 1947. They were used to buy arms, construction for the Iranian railway and foundation of a number of government enterprises.

Since the 1930s, government expenditure has been increasing in Iran. It is important to mention that until 1955, this expenditure was used to finance through taxation. After 1955, the oil revenues started to become the main source of the government budget. During the nationalization of the oil industry, Iran almost lost her oil revenues. It is worth mentioning that during the struggle for the nationalization of the oil industry the Bank of England restricted conversion of Iran's sterling holdings (Mahdavy 1970). The result was devaluation of the Iranian currency, with the value of the dollar increasing from 40 rials in 1950 to 124 rials in 1953.

However, devaluation of the currency, in contrast to Western expectations, stimulated the Iranian economy. Iran managed to export manufactured products like mill textiles and matches. At no time before 1929 did the revenue from oil exceed 19 per cent of the total Iranian state income (Ferrier and Bamberg 1982). It is worth mentioning that the employment effects of the oil industry in Iran were not significant; the peak time was before the oil nationalization in 1949, which was 78,162 Iranians, most of whom were unskilled labour (Bamberg 1994). It can be concluded that this is not in line with the common hypothesis of the resource curse, which believes in a shift of labour force from productive sectors to the oil sector.

While oil export was a significant part of the total export, almost 51 per cent between 1936 and 1959, the share of foreign exchange receipts from oil exports was rather small. During these times, non-oil exports were the main factor in balancing Iran's external account.

The contribution of oil to the Iranian economy was increasing, and by the first oil shock, oil revenue started to play a significant role in the Iranian economy. Although oil income was not the main source of the government's income, it represented a significant contribution to the economy as a source of exchange receipts. During 1947, 66 per cent of Iran's average annual foreign exchange earning was from oil royalties and sterling was received in payments for local currency. After oil nationalization, the influence of oil income on the Iranian economy can be examined from two different points of view. First, the money from oil was used for traditional public services such as defence, justice, welfare, health and education. Second, oil income was a source for financing development plans.

Oil revenue can make the government on the one hand independent, but on the other hand it can make it more vulnerable to crises. For instance, Katouzian (1981: 324) said:

> *"Oil revenues accrue to the state directly as large and independent sources of finance: the state does not even have to depend on the domestic means of production for their revenues… Once these revenues rise to a high level, making up at least 10 per cent of the national output, they begin to afford the state an unusual degree of economic and political autonomy from the production forces and the social classes of the country."*

To sum up, Iran before the revolution was moving towards becoming an industrial country. This was the result of both the government's policies and financial resources from oil revenue. The government policy to speed up the industrialization process was high protection along with subsidy. Given the detrimental effects of inflation on the poor, the state paid a substantial amount in subsidies to protect them. On the one hand, Lautenschlager (1986) indicated that the rich were the ones who benefited from subsidies for imported goods. On the other hand, it was proposed by Karshenas and Pesaran (1995) that subsidies were necessary to moderate the inflationary pressure on the poor specifically after the policy of exchange rate unification in 1993.

4.5 The Iranian Economy after the Revolution

In 1979, with the Islamic revolution, the political and economic policies of Iran changed dramatically. Ever since then, the country has been transformed into an Islamic country with a large public sector. Since the revolution, the Iranian economy has experienced four cycles: a deep recession immediately after the start of the Islamic revolution in 1979 and the eight-year war with Iraq; a minor recession between 1987 and 1989; a decent revival following the ceasefire with her neighbour

Iraq; and severe economic sanctions from the United Nations and United States due to uranium enrichment programmes.

Regardless of the Islamic government's initial purpose of decreasing the country's dependence on the oil sector, during this 34-year period the economy and government budget were closely tied to oil receipts. For some years after the revolution, the country had to deal with internal and external conflicts, the new political system and substantial extension of state controls over markets and businesses. It is important to mention that a number of internal and external issues also influenced Iran's economic climate.

Among the internal factors the most significant ones were the exodus of human and physical capital, political turmoil, uncertainties in economic activities in regard to private properties and favouring Islamic commitment over professional expertise in management choices. The challenges of managing deregulated markets built up a large foreign debt followed by a balance-of-payment crisis' in 1993-1994 (Esfahani and Pesaran 2009). As a result, the reforms in the credit and foreign exchange market failed to respond (Esfahani et al. 2013). Noteworthy external considerations were the very long and expensive war with Iraq (losing both human and physical capital), significant volatility in the international oil market, the freezing of Iranian foreign assets abroad in regard to invading the US embassy and hostages, and economic sanctions due to the uranium enrichment programme. The aforementioned events explain the unsatisfactory economic development in the post-revolution period. Although their effects were mitigated by foreign exchange reserves, and some policies, the economy's performance was not successful. The performance of the oil sector was significantly affected by the damages that occurred in the war with Iraq.

Oil production dropped from 5.6 million barrels a day (b/d) in 1976 to 1.4 million b/d in 1980-81. Although it increased again to 2.2-2.9 million b/d for the rest of the decade, it was still less than Iran's OPEC quota in some years, although it exceeded it in the rest. Iran managed to increase her production after the war with Iraq to 3.2-3.4 million b/d, but it was still less than its peak production in the 1970s. Consequently the share of oil income in GDP fell significantly from 30-40 per cent in the 1970s to 9-17 per cent in the 1980s. A number of different factors are responsible for the decline in oil production: the Islamic government's decision to cut oil production; the setting of Iran's oil field on fire by Iraq during the war; volatility in oil prices; and poor maintenance of wells due to the shortage of capital and technology. Despite all these drawbacks, oil revenue continued to account for almost 90 per cent of foreign exchange receipts in the country.

In terms of the industrial sector, the development was not satisfactory either. On the one hand, due to the political climate and revolutionary regulations of the initial years after the revolution, the substantial exodus of entrepreneurs and skilled workers, as well as physical capital, was a loss for the country. On the other hand, as a result of the freezing of Iranian assets abroad, along with economic sanctions and undesirable government policies in regard to multinational corporations, both foreign specialists and foreign investors left the country.

The situation got worse with a sharp reduction in oil income, which led to a significant cut in the import of industrial and raw material. Due to the difficulties of war, very slow economic growth and growing public expenditures, the government faced a budget deficit almost every year after the revolution. In some years, the budget deficit was even larger than the government's total revenue. As the budget deficit was totally financed by the quantitative easing by the Central Bank, the money supply increased almost ten times during this time. As a result of this increase in liquidity, prices went up both in retail and wholesale. Since many items in the consumer basket were subject to price ceilings, the true rate of inflation spiked. The government statistics indicate that the consumer price index increased by 637.5 per cent between 1979 and 1991 (Amuzegar 1992).

The first phase after the revolution was devoted to institutional reconstruction, and the economy was poorly managed. Although one of the aims of the new regime was economic recovery, during this period the regime considered a new guideline, "economics of divine unity", whose foundations were not based on conventional economic thoughts and rational allocation of resources. Therefore, rapid recovery was an unrealistic goal due to the problems and especially the spiking inflation, which created dissatisfaction toward the end of the Shah's regime. The Iranian economy faced a deep recession immediately after the revolution, and among a number of reasons for this one must emphasize the exodus of a massive number of skilled workers, the flight of capital and the withdrawal of Iranian managers and technocrats. The country's output continued to fall by 6.4 per cent whereas inflation continued to increase by 10.5 per cent (Alnasrawi 1986).

Another important reason for the recession was the hostage crisis in 1979, which ended in the freezing of Iranian assets in the United States. Along with the removal of $9 billion out of a total of $15 billion of assets from Iranian control, the Carter administration was successful in getting the support of other industrial countries in imposing economic sanctions against Iran. It is important to mention that massive nationalization of industries after the revolution was also a contributing factor to the inefficiency and low productivity in industry. In 1982, 130 nationalized industries went under the direct governorship of the three ministries that were ratified to conduct industrial policies. In addition, 450 industrial units went under the direct governorship of the National Iranian Industrial Organization. Apart from nationalization, several industrial units went under the governorship and into the possession of different institutes established after the revolution. Obviously they suffered from the lack of managerial skills and numerous changes leading to inefficiency. In terms of the agriculture sector, it can be said that it fared better than other sectors of the economy, since the lack of skilled workers, capital and technology did not negatively affect developments in this sector.

One year after the revolution Iran was invaded by her neighbour Iraq and went through an eight-year war. The massive cost of war and substantial fluctuation in oil income resulted in enormous budget deficits. The solution for financing the deficit was borrowing from the Central Bank since external borrowing was not possible due to resistance from the Iranian government. Thus, the government's significant debt was the main reason for inflationary pressure and acceleration in the economy. Another consequence of war was the destruction of the most important sector of the country, the oil sector.

Within a few days of the outbreak of the war, Iraq had managed to put Iran's oil exporting facilities out of operation. Iran's production decreased from 1.3 million b/d to 450,000 b/d. The loss of oil exporting capacity in Iran was by far the most disturbing economic result of the war. Since the oil shocks of the 1970s, oil had been the main contributor to GDP. In addition to the loss of oil revenue, the cost of rerouting imports from ports on the Persian Gulf through the Soviet Union and Turkey made the imports more expensive. Additionally, the diversion of resources because of the needs of the war increased Iran's dependence on foreign suppliers.

It can be concluded that the revolution and eight-year war with Iraq created several structural difficulties that required a long time to overcome. As mentioned earlier, among the impacts of the revolution and war were a significant reduction in oil production, market and income losses, a lack of foreign reserves, and the destruction of cities and infrastructure such as roads, harbours, pipelines and refinery. In addition, the growth of industrial and agricultural sectors was crippled and military supplies were depleted. Moreover, the loss of human capital created a labour shortage and serious internal refugee problems. All of these problems added to the general economic difficulties.

4.6 Economic Plans after the Revolution

The ceasefire with Iraq in August 1988 and the need for a proper development plan to reconstruct the country led to the launch of the new First Five-year Plan for the period 1989/90 to 1992/94. Despite the quadrupling of the price of oil in 1988, Iran's per capita gross national product (GNP) was returning to its level of 21 years earlier. The new government's policy to rectify the condition was liberalization, improving education and setting economic development as a major policy goal. The First Post-revolution Plan (1989-93) targeted the reconstruction of the economy through the sale of public enterprises, the reduction of trade barriers, tax reform and reconstruction of the banking system, among other things. In 1989, Tehran's stock market was reopened, and in the First Five-year Development Plan there was a legal outline for privatizing it. Therefore, the stock market became accessible again for selling public enterprises. The core objective of the plan was to achieve 8 per cent growth in GDP annually, which can be translated to a 5 per cent average annual increase in per capita income.

In addition, the Plan assumed a significant drop in the fiscal deficit from 2146 billion rials in 1988 to 92.5 billion rials by the end of 1994 (Ghasimi 1992). In order to moderate the rate of inflation from 28.9 per cent to 8.9 per cent the following steps were taken. First, the policymakers expected that the estimated decrease in fiscal deficits would reduce the pressure on the domestic banking system. Subsequently, the indebtedness of the public sector to the Central Bank, which was the main factor in accelerating liquidity, would diminish. Eventually, the growth rate of liquidity can be expected to drop from 23.2 per cent to 3.8 per cent (Ghasimi 1992). In terms of revenue from oil, the plan predicted a rise in oil prices from $14.2 per barrel to $21.4 per barrel, which can be translated to a spike in the oil revenue from $7.3 billion to $17.9 billion by the end of 1994. In other words, foreign exchange earnings from oil should be enough for almost 71 per cent of the plan requirements in order to import. In terms of the industrial sector, it should be said that during the 1980s it had the least satisfactory performance. During the 1980s, most of the time a negative growth rate was registered, ranging from -9.1 to -1.6 per cent.

The growth rate of GDP in the first year of the plan was 4.3 per cent compared to the target of 10.8 per cent. At the beginning of the second year, due to the considerable development of the services in 1990, 10 per cent growth was achieved.

In 1994-1995, a sequence of events including a drop in oil prices, mismanagement of the economy in general and the exchange rate specifically brought economic growth to a halt.

Apart from conceptual inconsistency, ever since the revolution the overall performance of the economy during the five-year plan was the best. It is important to mention that a number of unexpected factors, such as a significant idle industrial capacity free from war, a huge spike in oil prices, a rise in imports and a reduction in population growth, helped the situation. Although the average growth rate of GDP was about 7 per cent and in general social indicators had improved, a number of the plan's quantitative targets had not been achieved. By the planners' own admission, the objectives of privatization, the exchange rate and trade liberalization had not been implemented successfully (Amuzegar 2001). A number of factors, including low returns on public investments, a rapid increment in public demand and declining foreign exchange reserves, increased inflationary pressures and this lasted until the mid-1990s.

The Second Plan was initially supposed to be launched on March 20th 1994; however, for a number of reasons, such as internal and external imbalances from previous miscalculations and a slump in international oil prices, the Plan was postponed until March 1995. All the unresolved and accumulated problems of wartime collectively came out in 1994/95. The most significant one was the unification of a complex exchange rate system inherited from wartime regulations, which was one of the main targets of the First Plan. In March 1993, the exchange rate depreciated from 70 Iranian rials (RIs) per US dollar to IR 1600 to the US dollar. Nevertheless, given the unstable economic situation, short-run foreign debt and failure of the Central Bank to service external debt along with escalating inflationary pressures, the unified exchange rate system was abandoned in December 1993. The exchange rate depreciated further to 1,750 Iranian rials per dollar in 1994, along with strict policies on foreign exchange accessible for travel and trade restrictions. In 1996, Iran applied to join the WTO for the first time, but was not successful. In total, Iran applied to join the WTO 22 times but the application was rejected on every occasion.

As a result of these strict policies, the country was successful in reducing monetary, fiscal and external payment imbalances. In addition, the Central Bank managed to refinance the external arrears payment through bilateral agreements with Iran’s trade partners. Yet inflation stayed high at around 35 per cent and the annual growth of GDP remained at about 1.6 per cent, which was its lowest level for years. Imports were cut to a third of their level in 1991 in order to increase foreign exchange reserves. Simultaneously a new exchange rate of 2,345 Iranian rials per US dollar as a rate for export was added to the official rate. All these measures together helped change the current account balance into a surplus.

Therefore, the Second Development Plan (1995-2000), which had been postponed for a full year on the evening of the launch, still encountered some growth-inhibiting bottlenecks. The Second Plan was introduced taking into consideration all the problems and was more realistic in its goals and less ambitious in its calculations. It promised to speed up the structural improvements that had been promised in the First Plan and to continue with macroeconomic adjustments. The Plan had 16 central targets but three parts of the Plan needed specific attention. For GDP growth, aggregate investment, employment, liquidity, foreign trade and population-specific quantitative goals were considered.

It is important to mention that each category was broken down into more detailed goals. There were detailed projects in oil, gas, metals, minerals, water and public transport. The target for annual GDP growth was 5.1 per cent on average, with an increase of 6.2 per cent in domestic investment annually. Government consumption was supposed to decrease by about 0.9 per cent annually. Furthermore, the inflation target was about 12.4 per cent per year. In terms of trade, imports were supposed to rise by about 4.3 per cent, oil exports at the rate of 3.4 per cent and non-oil exports by around 8.4 per cent. It was expected that these objectives would significantly decrease the ratio of public consumption to GDP, and lead to spending a substantial portion of public expenditures on investment, and also reducing the annual budget deficit to zero. Despite the implementation of the First and Second Plan, the unification of the exchange rate, the structural change of the economy and the ceasefire with Iraq, the government was not very successful in their attempts to improving economic conditions. The economy was facing 20.1 per cent inflation, and a high unemployment rate of 16.2 per cent. The Second Plan failed to remove subsidies and unify the exchange rate. In addition, it increased the country's foreign debt to $30 billion (Valadkhani 2001).

The new government in 1997 with President Mohammad Khatami indicated that Iranians "deserve a better deal" after the revolution, eight-year war and reforming and constructing after war. The new government promised to deal with these difficulties with appropriate policies. The measures proposed by the new government were balancing budgeting, privatization, finishing projects before starting new ones, and adjusting the exchange rate. The government's solution to challenges in the economy was a strategy called the "Economic Rehabilitation Plan" (ERP). The new manifesto listed the economic challenges of the country as follows: reducing unemployment, investment to be able to finish ongoing projects, reducing monopolies, improving the treasury's fiscal structure, decreasing high inflation and providing a better positon for Iran with its major trading partners.

However, the ERP was not very successful in achieving its goals. A precipitous reduction in the oil prices played a significant role in the failure of the ERP. A decline in government oil incomes from 1997 caused a chain of challenges such as worsening external debt, a rise in budget deficit, reduction of imports, increase in inflationary pressures, devaluation of the Iranian rial and in general a recession. Hence, all eyes turned to the Third Development Plan proposal (2000-2005) and the ERP never achieved any of its objectives.

The Third Development Plan was proposed with the following six central targets: first, a more transparent economic system; second, reforming the government budget; third, reforming the tax system; fourth, privatization of government enterprises; fifth, taking down monopolies and promoting competition; and finally, protecting vulnerable groups by launching an inclusive social safety net. Yet, unlike the last two plans, the most significant concern of this plan was an increasing unemployment rate. The reason why all of a sudden reducing the rate of unemployment became a key target for the economy was the high number of young people who were looking for jobs. One of the government policies after the revolution was encouraging population growth, particularly in the 1980s. Therefore, the population pyramid in Iran can be referred to as a "time bomb" (Valadkhani 2001).

In the years from 1996 to 2000, about 296,250 new jobs were created annually, while each year about 692,750 new job seekers entered the job market (Valadkhani 2001). A Third Plan predicted that in the course of 2000-2005, on average every year between 750,000 and 800,000 job seekers would look for jobs; however, if the country continued with the approach of its last Plan, each year roughly half a million people would be added to those job seekers who cannot enter the job market. The Third Plan indicated that GDP would need to grow by about 6 per cent each year just to maintain the current rate of unemployment. Over the course of 1994 to 1999, real GDP grew by just 3.1 per cent every year, and during the last decade it grew by only 3.2 per cent per annum. The aim of the Third Plan was to reach a growth rate of 8.5 per cent, while according to Valadkhani (2001: 12), “the private sector in Iran has been treated as residuals”. In 2000-2001, the spike in oil prices allowed the government to establish the Oil Surplus Fund for saving oil revenues above a specific level. The purpose of the fund was to mitigate the negative impact of extreme fluctuation in the international oil market and accumulate cash reserves to help reduce the unemployment rate and promote exports. In addition, the fund was used by the state to stabilize the exchange rate by intervening in the foreign exchange market. Consequently, the Iranian rial’s value increased from 9,040 rials per US dollar in August 1999 to 7,970 rials per US dollar in August 2001. Moreover, because of higher oil receipts, for nine months in 2000 Iran’s trade balance was positive at $10.6 billion.

By the end of the Third Development Plan, Khatami’s administration had prepared the Fourth Development Plan. Then President Ahmadinejad took office, and the new president promised economic justice and fairness. The most significant economic change of his government was a reduction of the generous subsidies of government. Apart from this, the country experienced increasing Western sanctions as a consequence of the government's political policies. The new government refused to endorse the Fourth Development Plan (2005-2010), which had been prepared under the previous government's administration.

Abruptly, Ahmadinejad shut down the 60-year-old Plan Organization (which had been responsible for Iran's economic development plan since 1945). In terms of publishing data on fundamental economic indexes in the first round of Ahmadinejad's presidency, his administration stopped revealing data on growth. Interestingly, data on both inflation and unemployment revealed by the Central Bank and Statistical Centre were inconsistent. Data on foreign exchange reserves were categorized as "confidential" and never released. Budget deficits became secret by considering borrowing as revenue (Amuzegar 2013).

The main targets of the new government were justice, fighting against poverty, corruption and discrimination. Yet the president believed there was no need for an economic plan and that these objectives would be achieved without any plans. The new government started with a highly expansionary policy whose first step was to increase the fiscal budget. The higher fiscal budget was provided by the Central Bank printing more money. The annual budget increased significantly from 1,590,000 billion rials in 2005 to 7,280,000 billion in 2013, with a deficit each year. In addition, the state sector's debt to the Central Bank increased from 236 trillion rials to 1,152 trillion. The oil receipt that this government received was different from all the previous Iranian governments.

A spike in oil prices gave the country $700 billion compared to $440 billion received by governments since the Islamic revolution, and interestingly, five times the receipts between the finding of oil and the termination of the Pahlavi regime. The country was facing a double-digit price hike from perpetual budget deficits and increasing debt to the Central Bank. The policy of government to deal with this demand created by economic disequilibrium was concentrating on the supply side. To do so, the government decided to dictate three fundamental cost factors of households and businesses: the exchange rate, the interest rate and basic energy prices. The outcome was not very satisfactory in any of these three areas. The Iranian currency was kept artificially overvalued. This resulted in: a reduction in the ability of domestic producers to enter the international market; a decreasing domestic production capacity of import by almost 30 to 40 per cent; stopping a significant number of workers; and exacerbating the country's non-oil trade balance.

Needless to say, the artificially overvalued currency caused Iran to depend more heavily on the world economy even for necessary food items, and as a result capital flight. Along with these problems, due to the political policies of the government, a new round of tough sanctions was imposed on the Iranian Central Bank and oil sector in 2011. Consequently the Iranian rial plummeted against the dollar and lost two-thirds of its value. This moved the economy towards an era of uncertainty. In 2009, the exchange rate was 10,000 rials per US dollar and the inflation-adjusted equilibrium according to the Central Bank's estimation was 24,000 rials.

Strangely enough, the government applied a new policy of interest rate regulation, holding interest rates on savings below inflation and keeping bank fees on loans below free-market levels. The subsequent outcome of low returns on deposits encouraged people from productive investment to move capital from banks to real estate, the US dollar and the gold market. The result of losing saving deposits forced commercial banks to borrow from the Central Bank, which led to a significant debt. Alongside these problems, energy prices were also artificially low for a long period, which caused profligate energy consumption and the growth of energy-intensive industries that were vulnerable to international economic shocks. It is worth mentioning that energy smuggling to neighbour countries became a problem as a result of these policies.

All of these problems were reflected in major economic indexes. The growth rate of GDP was 6.9 per cent in 2005, which was on a downward trend until it got to -1.7 per cent and -5.4 per cent in 2011 and 2012, respectively. The official consumer price index, which was 10.4 per cent in 2005, started to rise gradually, eventually exceeding 40 per cent, which was the world’s third highest in 2013 when Ahmadinejad left office. The reason behind the high inflation and increase in liquidity was three projects implemented by the government. First, there was a project called “Quick Returns”, aimed at creating 2 million new jobs. The second project was “Low-cost Housing in City Margins”. The third project was a novel project of cash payments based on reconstructing subsidies on energy. However, all three of these projects were considered unsuccessful. According to Amuzegar (2013), the housing project alone was responsible for 40 per cent of liquidity.

As well as all the inappropriate government policies, ever since the revolution the United States has imposed sanctions on Iran. They were originally started by President Jimmy Carter in 1979. According to these sanctions, Americans were banned from importing any manufactured goods from Iran. In addition, exports of both American goods and services to Iran were prohibited. However, the sanctions changed in 2005 when the Iranian government decided to develop nuclear technology and resume uranium enrichment. Because of this decision by the government, the United States imposed numerous sanctions against Iran in different sectors, including transportation, banking, oil, gas, petrochemicals and pharmaceuticals.

The logic behind these strict sanctions was that any income from Iran's energy sector can fund Iran's nuclear programme. The sanctions became really strict in 2010. Since then, any company from any country around the world would have been under US sanctions if a single shipment of fuel to Iran had been worth more than $1 million, or in the course of a year shipments had been worth more than $5 million. Needless to say, these conditions were applied to any service associated with fuel trade with Iran. Initially, Iran's oil export decreased from almost 2.5 million b/d in 2011 to almost 1.1 million b/d in 2013. Apart from the reduction in oil export, the international oil prices dropped, which made the situation even worse. Furthermore, according to the sanctions, $120 billion of Iranian reserves abroad became inaccessible. The country's economy shrank by about 9 per cent from mid-2012 to March 2014.

In 2010, sanctions targeted the gas and oil sector of the country and significantly affected the Iranian economy. On January 20th 2014, an agreement to lift some sanctions went through and this gave Iran the chance to revive its economy. Relief from sanctions gave Iran the option to freely export oil, which can be paid for directly with hard currency. In addition, Iran's banking system has been reintegrated into the world financial system and the country can access its hard currency reserves abroad. A number of international energy firms started to invest in Iran's energy sectors from the time sanctions were removed.

The Fifth Plan (2010-2015) was prepared under Ahmadinejad's administration and approved by the Majlis. Nevertheless, the Fifth Plan remained mainly at the planning stage. In terms of the role that oil has played historically in Iran, it can be said that oil income, both before and after the revolution, has been influential in financing Iran's development plans.

Although Iran is one of the main oil exporters in the world, Jalali-Naini (2003: 18) states that "basic development in Iran since the mid-1950s has been a planning framework in which the oil industry, as the 'leading sector' and the engine of growth supplies surpluses (saving) for investment in other sectors". For sure government policies have played a key role in Iran's economic performance over the last forty years. Data of the central bank of Iran and Hakimian (1999) (in appendix four) show that all: the real gross domestic product, the gross national saving and the gross fixed capital formation consistently grew during 1960 to 1978 in line with the growth in the private sector. Nevertheless, the high co-movements in the aforementioned variables came to an end when the first oil shock happened. Higher oil income fuelled an economic boom which caused inflation and affected economic growth adversely in the late 1970s.

More recent theoretical work has derived a specific linkage between saving and development. According to them if adjusted net savings are positive, the present value of social welfare is increasing. On the other hand, if adjusted net saving is negative it means the present value of social welfare is decreasing and also the level of social welfare in the future along with development path should be lower than present social welfare. In the case of Iran this data is very limited as it can be seen in figure (4.1).

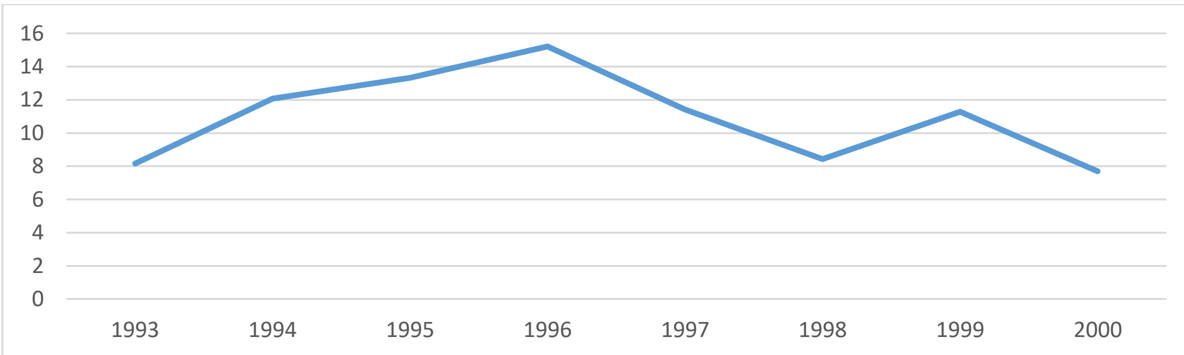


Figure (4.1) Adjusted Net Saving

Source: The World Bank

4.7 Oil Stabilization Fund (OSF) in Iran

The Iranian Oil Stabilization Fund existed for a short period between 1999 and 2004. However, the establishing of oil funds in other oil-rich countries goes back to the failure of the price-stabilizing power of OPEC (Amuzegar 2005). The Iranian Majlis have never received an official balance sheet from the OSF despite a clear order by law; therefore, the figures in this research were obtained from Amuzegar (2005), who put together these data from various sources such as the Fund's secretary's general statements, Majlis deputies' speeches and reports in the local press.

The law's provisions state that the $74 billion surplus income from oil should be placed in the OSF. The overall oil income projected in the Third Development Plan built on expected oil prices was $56.7 billion based on expecting oil prices to be between $12 per barrel and $19 per barrel. Nevertheless, with the spike in oil prices to about $35 per barrel, the oil income increased by more than twice what was predicted and reached $130.7 billion. However, deposits in the OSF in five years amounted to almost $29.1 billion. Meanwhile the Majlis raised the oil share in the budget each year. Adding its own interest the value of assets in the OFS turned to a total of $30.2 billion.

On top of depriving the OFS of the $74 billion to which it was entitled, the Majlis overlooked the original aim of the fund and the fund's board, which was followed by continual authorized withdraws of almost $17 billion to finance different projects. For instance, $9.4 billion was allocated to urgent projects aimed at providing relief for drought-stricken farmers and end-of-year bonuses for government pensioners, as well as payments for petrol imports. About $7.6 billion was allotted to the Central Bank for losses that occurred in foreign exchange unification. In addition, some other money was paid as grants to disabled war veterans along with supplements for subsidies on essential commodities. It is worth mentioning that none of the above-mentioned projects were related to the purpose of the Fund.

Almost $11 billion credit was allocated for loans to the private sector. However, only $6.8 billion was approved for some projects. The usual length of these loans was about eight years and the annual interest rate was 2 per cent. For some specific projects the length was extended to ten years. Most of the credit for the private sector went to projects in mining and the industrial sector, and what remained was allocated to transportation, technical services and agricultural sectors. In general, only a small portion of the OSF was used by the private sector due to the unappealing terms of the loans.

The reason why these loans were unattractive was that they were in foreign currencies, and in addition they had to be used for foreign purchases, and paid back in foreign exchange. Consequently, although the interest rate was 3-5 per cent, which was significantly lower than the interest rates of commercial banks, the ultimate borrowing costs could have run much higher due to the volatile exchange rate. With the Iranian rial on the downward trend, the exchange-adjusted effective annual interest rate to be paid back was 20 per cent. In other words, the loan was charging a 15 per cent rate for rial depreciations. In general, from $30 billion of assets, almost $17 billion was used in the public sector, and $3.7 billion was used as loans to the private sector. By the end of the Third Plan, the OSF had reached $13 billion in total including $9.4 billion in cash and $3.5 billion in outstanding loans.

In general, it is not easy to conclude how the economic performance of Iran would have been if oil was not there. In order to get an idea of how Iran would have performed without oil we compare Iran's important economic indexes with South Korea. Iran's GDP per capita in 2016 was 5,027 dollars which is far below of South Korea's 27,535. The education expenditure of South Korea was 69,858 which is significantly above Iran's 10,995. Unemployment rate in Iran was 12.5%; however, the same index in South Korea was 3.2%. It is important to mention there are significant cultural and religion differences between two countries which can to some extent explain the different outcome. However, bearing in mind all differences in 1955 Iran's GDP per capita was higher than South Korea which changed dramatically in the course of five decades.

4.8 Conclusion

May 2008 was the 100th anniversary of discovering oil in commercial quantities in Iran. In other words, oil has been produced in Iran for over a century, and yet there is no general agreement on its role or whether it is a blessing or a curse for Iran. The country is the oldest oil producing country in the Middle East. Moreover, oil has been the main export of Iran for a long time and it is the world's number one strategic good. As oil revenues have increased to the point where they dominate the Iranian government's revenue sources, the government has changed from an extractive state into a distributive one. Relying heavily on oil revenue subjects the government to extensive fluctuations in its main source of income.

All in all, during the period 1901-1951, the impact of the oil industry on the Iranian economy, apart from employment and domestic use, was insignificant. However, oil revenue financed over 66 per cent of the Third Plan, 63 per cent of the Fourth Plan and almost 80 per cent of the Fifth Plan. In 1951, oil was nationalized in Iran by Prime Minister Mosaddegh. This action by the Iranian government caused difficulties for newly established industries. The data illustrate that oil receipts were the source of financing economic development plans.

It has been shown in this chapter that Iran progressively transformed from a farming-based society to a modern economy through significant changes in the traditional socio-economic order. Public planning, urbanization, diversification and investment in infrastructure all helped in this process. Needless to say, most of the plans and projects were financed by oil rents. The government managed to achieve sustained growth through controlling imports, management assistance and helping the private sector. For almost a decade until 1978, the state was successful in achieving its economic goals.

Since the 1980s, the Iranian economy has grown unevenly. Although since the mid-1970s the share of oil revenue as the major source of foreign exchange in the economy decreased, the oil sector continued to play a central role in the economy. In essence, oil export was reflected in the growth of real output between 1981 and 1986, which was about 8 per cent annually. Likewise, the major weakness in the oil sector was the main reason for the fall in real output in 1988 of about 10 per cent. Again in 1989, this pattern continued, when economic growth was 4.3 per cent as a result of the recovery in oil production and export.

All in all, oil has been Iran’s economic lifeblood, and since the 1970s the well-being of the Iranians has been tied to the international oil prices. It can be concluded that a positive correlation between the oil sector and economic growth has always existed in Iran. An evaluation of the economy’s post-revolutionary performance is not very satisfactory: the growth of GDP on average in the last 35 years was 2 per cent per year, somewhat less than the annual population increase, which was about 2.4 per cent.

If oil revenues are only used in short-sighted plans, they increase consumption without creating dynamic impacts on the production structure of the economy. Moreover, if rents are considered temporary income for the government, the result will not be any different. As previously mentioned, oil has been produced long enough to be part of the long-term output equation in Iran. This overview is intended to provide a fairly comprehensive economic history of Iran over the last 54 years. In addition, it outlines the major events that lie behind the data that will be presented in the econometric analysis in the following chapters.

Appendix 4

Table (4.1) Development Plans in Iran before the Revolution

Development Plans	Percentage financed by oil
First Plan (1949-55)	37%
Second Plan (1956-62)	73%
Third Plan (1963-67)	66%
Fourth Plan (68-72)	63%
Fifth Plan (73-78)	80%

Source: Plan and Budget Organization

Table (4.2) Real GDP, Saving Investment Growth Rates (percent)

Era	Period	GDP	Saving	Investment
Pre-Revolution	1960-78	9.0	16.2	11.4
Post-Revolution	1979-03	2.5	6.2	4.3
War years	1980-88	-1.5	6.5	-1.5
First Plan	1989-94	7.5	7.7	4.6
Second Plan	1995-99	3.2	5.2	10.1

Source: Plan and Budget Organization

Chapter Five

THEORETICAL FRAMEWORK AND METHODOLOGY

"The proximate causes of economic growth are the efforts to economize, the accumulation of knowledge, and the accumulation of capital." Lewis (1955)

5.1 Introduction

This chapter aims to build up theoretical foundations for testing the impact of oil income on the Iranian economy. Chapter Two highlighted the significant features of economic growth and explained economic growth theories in detail. Thus, the reviews of related growth theories and empirical literature on the resource curse in Chapters Two and Three will be used as a basis to inform the foundation of the econometric model undertaken in this thesis. It is worth mentioning that theoretical models of growth mainly concentrate on either technology or human capital as the main drivers of economic growth. It could be said that the potential role of natural resources has been ignored in modern growth theories. Likewise, most empirical research on economic growth eliminates countries with natural resource endowments from their cross-country analysis. This chapter aims to introduce a suitable theoretical framework, which fits the purpose of this study. This thesis is in line with studies that look at the long-term impact of oil revenue on economic growth since its general purpose is to determine the effects of oil revenues on economic growth in Iran over the period 1955-2014.

In order to introduce a theoretical framework to test our hypothesis, it is necessary to use either a neoclassical or an endogenous growth model. Previous chapters emphasized some significant features of reality introduced into growth theories. They did so through endogenous growth theories like increasing returns to scale and innovation. However, the considerably different features of endogenous models compared to neoclassical ones need very special parameters, which make them too difficult to test empirically. Therefore, using a neoclassical framework augmented with some of the main variables in an endogenous framework looks to be a more reasonable option for investigating the relationship between oil income and economic growth.

Different studies have developed a number of modifications to the neoclassical framework to stress the role of some determinants in explaining economic growth. For instance, the human capital added to the Solow model was illustrated in the work of Mankiw et al. (1992). Another version of an augmented Solow model was introduced by Nonneman and Vanhoudt (1996) by adding accumulation of technology through R&D. Knowles and Owen (1995) presented an augmented Solow model by adding health and longevity. In the same line of research, this study will use the neoclassical model as the basis for its theoretical framework.

Following the introduction, Section 5.2 introduces a theoretical model, which enables the estimation of the impact of oil revenues on economic growth. Section 5.3 discusses the data for different variables that the econometric model will take into account. Furthermore, the source of data and their quality and reliability will be discussed in Section 5.4. Section 5.5 deals with choosing the right methodology and explaining the details for choosing that method. Section 5.6 analyses data to be used in an econometric model. Finally, some conclusions will be drawn in Section 5.7.

5.2 Theoretical Model

As discussed in Chapter Two, within the neoclassical models, natural resources, and in particular oil, which this research is concerned with, have no role in determining the long-term economic growth rate. Therefore, long-term economic growth is not driven by natural resources (Ayres and Warr 2010). In the neoclassical models that will be the foundation for our theoretical framework, the growth rate is determined by the exogenous technological growth rate and capital accumulation. However, some scholars, such as Hartwick (1977), have suggested that to achieve sustainable economic growth in resource-rich countries, natural resources should be completely transformed into physical capital. In neoclassical models the growth rate is determined by the exogenous technological growth rate and capital accumulation. It is worth mentioning that the revenue from the sale of natural resources pays for capital accumulation, therefore it affects growth.

The versatility of the neoclassical models enables the analysis of issues that are omitted from the basic model. For instance, in the Solow model, oil can be a factor of production. On the other hand, endogenous growth theory rekindled attention towards innovation in generating long-term economic growth. Although the driver of growth in endogenous growth models differs – for instance, human capital in Lucas (1988), knowledge in Romer (1990), and technology in Grossman and Helpman (1991a) and Aghion and Howitt (1992) – natural resources are not among the factors of growth. However, resources, including natural, human, physical capital and technology count in any economic growth model since they form the Production Possibility Frontier (PPF) of a country. According to the endogenous growth literature, the accumulation of human capital, knowledge or technology happens as a result of a decision by private and public sectors in the economy that would create growth.

A strand of growth literature that highlights the impact of oil revenue on economic growth was discussed in Chapter Three. The conclusion indicated that the empirical evidence on the role that natural resources play in economic growth is rather mixed. The inconclusive nature of theoretical and empirical studies provides the basis for further empirical research on this issue. To evaluate empirically how oil affects the Iranian economy, a theoretical framework is necessary.

There are two leading theoretical approaches that have mainly been used in the literature. One is the optimization of problems faced by a “representative household” or firms, which uses the Euler first-order condition to solve long-term issues, as adopted by Cavalcanti et al. (2011b). The other one is the theoretical model that Esfahani et al. (2014) developed for major oil exporting countries. This research is built on the theoretical outcomes of Esfahani et al. (2014). The results provide further evidence on the empirical validity of the long-term relationship between oil and output. Therefore, by considering the role of oil income in the production function, the theoretical framework is developed.

The model is basically a variation of a neoclassical growth model that is developed by including oil income as an additional factor that is added in the capital accumulation process. It is assumed that saving that turns into investment for capital accumulation consists of two parts: one is saving from oil output, and the other is from non-oil output. According to the finance-led growth hypothesis, the existence of an efficient financial system has a positive impact on growth. In this literature, any economy will grow faster if the financial system, mostly banks, can allocate resources efficiently. In addition, since the process of turning savings into investment should take place through a financial system, the role of financial development in the economic output equation will be considered. Moreover, the effects of natural resources and financial development through an interaction term will be analysed.

The very first assumption in using the following theoretical framework is that the oil revenue-output ratio should stay relatively high and it would remain high in the case of Iran for a reasonably long period. Oil was discovered in Iran over a century ago, after a massive exploration and production, and the British Petroleum Statistical Review of World Energy suggests another 85 years of extraction (British Petroleum 2016). Furthermore, the reserves in Iran are not limited to those that have been extracted, as the oil in the north of Iran has not been touched yet. Taking those reserves into account, Iran has remarkable oil reserves. Needleless to say, oil reserves are not constant and they depend on oil prices; therefore, with higher prices the reserves will increase. It can be concluded from the above that oil can be considered a factor of production in the output equation in Iran since oil resources are not a short-term discovery, unlike the Dutch Disease and resource curse hypothesis, which consider the income from resources transitory.

5.2.1 Long-term Output Equation for Iran

The approach here is to adopt a growth accounting model, where economic growth is the measure of economic performance, and for economic growth we look at real output per capita. It is assumed that output in Iran is a neoclassical production function with a diminishing marginal product of physical capital. According to Inada conditions, the marginal products of capital and output move towards infinity as their values move towards zero, and towards zero as their values move towards infinity. Considering a Cobb-Douglas production function with constant returns to scale, we have:

$$Y_t = A_t K_t^{\alpha} {L_t}^{1-\alpha} \tag{5.1}$$

where Y_t is output, K_t is physical capital, L_t is labour and A_t is the level of productivity. It is believed that L_t is exogenously given and grows according to the following linear processes:

$$\ln(L_t) = L_0 + nt + u_{lt} \tag{5.2}$$

where L_0 is the initial endowment of labour, n is the growth rate of labour at a steady-state point, and following the literature, u_{lt} follows general linear processes, probably with a unit root.

The value of capital in terms of per capita will be:

$$k_t = \frac{K_t}{L_t} \tag{5.3}$$

Therefore, the production function can be written in per capita terms as:

$$y_t = A_t k_t^{\alpha} \tag{5.4}$$

Since the study aims to look at the impact of oil revenue on the Iranian economy, let's indicate the real value of oil export Oi_t as follows:

$$Oi_t = \frac{EX_t p_{ot} O_{ot}}{inf} \tag{5.5}$$

Since any surge in oil prices leads to an increase of the oil prices in relation to the prices of investment goods the real returns on investments in these sectors of the country will increase. Thus, it is important to mention that per capita income will automatically increase if the oil revenue increases which is considered in the theoretical model.

where EX_t is the exchange rate in terms of the US dollar, p_{ot} is the price of oil per barrel, O_{ot} is the number of barrels of oil exported and inf is inflation.

oi_t refers to the real oil income in terms of per capita.

$$oi_t = \frac{Oi_t}{L_t} \tag{5.6}$$

Following the literature, a Keynesian capital accumulation function can be written as follows:

$$dk/_{dt} = sy - (n + \delta)k \tag{5.7}$$

where $dk/_{dt} = I$ is investment and s is the share of gross saving in output per capita. Assuming a proportion of savings $(1 - \varphi)$ is used as the cost of financial intermediation, the saving investment identified for the economy is $I = \varphi S$.

Some scholars such as Modigliani (1970) and many others provide evidence that there is a positive correlation between saving and output for a significant number of countries. This positive correlation supports the Solow growth model in which a higher saving rate causes transitory growth to a higher steady state level of output. There is a growing evidence that the causality can run the other way around which is from growth to saving, called the Carroll-Weil hypothesis. Although the powerful empirical association between saving and investment has been stressed, there is no consensus explanation about this link or its direction. In this research, following the Solow model we assume saving increases investment and following that the output increases.

It is considered in a major oil exporting country like Iran that savings come from two sources, either from the oil output of the country or the non-oil output of the country. The equation below illustrates the saving function of the country:

$$S = \mu(\varsigma_t)X_t + \lambda(\varsigma_t)Oi_t$$

where O_t is the oil output and X_t the non-oil output, and $\mu(\varsigma_t)$ and $\lambda(\varsigma_t)$ are the shares of non-oil output and oil revenue that are saved and invested. In addition, $\varsigma_t = (S_t, x_t)$' is the vector of state variables. It is assumed that both $\lambda(\varsigma_t)$ and $\mu(\varsigma_t)$ lie in the range of $(0,1)$[1]. The investment function can be rewritten as follows:

$$I = \varphi(\mu(\varsigma_t)X_t + \lambda(\varsigma_t)Oi_t) \qquad (5.8)$$

It is assumed that the combination of non-oil output and oil output generates the Iranian output. In equation (5.8) $\mu(\varsigma_t)$ is the share of saving in non-oil output per capita, $\lambda(\varsigma_t)$ is the share of saving in oil output per capita, n is population growth and δ is physical capital depreciation.

$$X_t + Oi_t = Y$$

It is important to mention that oil can included in the production function of non-oil production, however; an econometric model with oil as an input can suffer from

[1] $0 < \lambda(\varsigma_t) < 1$ and $0 < \mu(\varsigma_t) < 1$

endogeneity. Given this problem we consider the role of oil in the economy through the oil output. Arora et al. (2013) indicated in their work that how including oil revenue in non-oil output can cause endogeneity.

Going back to the Keynesian capital accumulation rule:

$$dk/_{dt} = sy - (n + \delta)k \tag{5.9}$$

where $dk/_{dt}$ is the rate of change in per capita physical capital, which is considered to be equal to saving minus population growth and capital depreciation. By setting (5.9) equal to zero the steady-state solution for the physical capital per capita will be:

$$k = {(\mu(\varsigma_t) + \lambda(\varsigma_t))y}/_{(n + \delta)} \tag{5.10}$$

Taking the logarithm of both sides of the equation and replacing the steady-state solution for k, the steady-state solution for output per capita is as follows:

$$lny_t^* = \left[1/_{(1 - \alpha)}\right]\left[lnA_t + \alpha\ln\varphi(s/_{n + \delta})\right] \tag{5.11}$$

Mankiw et al. (1992) state economy moves towards its steady-state solution according to

$$lny_t - lny_0 = \theta(lny_t^* - lny_0) \tag{5.12}$$

where θ is the adjustment towards a steady state.

Following Mankiw et al. (1992) we have $\theta = (1 - e^{-\eta t})$

where η is the speed of convergence. From (5.11) we can work out the growth of per capita output, which is

$$g_t = \left({}^{\theta}/_{t}\right)(lny_t^* - lny_0)$$

Replacing lny_t^* by its equivalent from (5.11) we have the relationship for actual growth of per capita output:

$$g = \left({}^{\theta}/_{t(1-\alpha)}\right)\left[lnA_t + \alpha \ln \varphi \left({}^{s}/_{n+\delta}\right)\right] - \left({}^{\theta}/_{t}\right)lny_0 \qquad (5.13)$$

Since oil prices are identified in the international market, and are the main drivers of oil income, what will explain them best is a random walk model with drift. The rationale behind choosing a random walk with drift is that in line with the literature on oil prices, there is no useful information on historical oil price movements. In addition, the history of oil price fluctuation shows that prices are unpredictable. Furthermore, the oil price graph indicates that there are intercepts and trends that can be translated to a random walk with drift (slow steady movement and deterministic trend).

$$\Delta ln(Oi_{t+1}) = g^o + \Delta v_{t+1} \qquad (5.14)$$

Where g^o is the drift coefficient, and $v_t \sim i.i.d.(0, \sigma_v^2)$, then oil income per effective labour will be:

$$\Delta \ln(Oi_{t+1}) = g^o - n + \Delta v_{t+1} - \Delta u_{lt+1} \qquad (5.15)$$

To test the long-term relationship between real oil revenue and other variables in the economy, real oil income can be decomposed to:

$$\ln\left({}^{Oi_t}/_{L_t}\right) = \ln\left({}^{EX_t}/_{inf}\right) + \ln\left({}^{p_{ot}Oo_t}/_{L_t}\right) \tag{5.16}$$

where $\left({}^{EX_t}/_{inf}\right)$ refers to the exchange rate divided by inflation and $\left({}^{p_tOo_t}/_{L_t}\right)$ denotes the number of barrels times price of each barrel divided by labour.

Since the study has adopted a neoclassical model, and in the neoclassical framework one key determinant of economic growth is investment, this study looks at the quality and efficiency of investment. To do so, we look at the financial development, and the interaction between financial development and oil income. It is important to mention that in Iran, the government participates significantly in the financial sector. The role of financial development will be taken into account through total factor productivity. It is assumed that total factor productivity takes the following generic form:

$$A_t = f(FD_t, Oi_t, V_t) \tag{5.17}$$

where FD_t is financial development, Oi_t is oil income and V_t is volatility. Needless to say, volatility is inevitable in any income from natural resources, particularly oil. As a result, it can be concluded that volatility is transformed to other parts of the economy in Iran since the lion's share of the government's income is from oil. In (5.17), V is a proxy for volatility in the economy, which has been measured by volatility in oil prices. Here we take into account the role of financial development and oil revenue with an interaction function. Where f is a transition function, FD stands for financial development.

In addition, dummy variable will be added to account for specific events in Iran such as the Islamic revolution in 1979 and the eight-year war with Iraq (1980-1988). It is worth mentioning that the general literature concerning the interaction between growth and FD suggests a positive correlation between them. According to the literature on economic growth, there is a positive link between growth and financial development. To include this interaction in our model, we include an interactive term as follows:

$$A_t = \beta_0 A_0 + \beta_1 lnFD + \beta_2 V + \beta_3 (FD * Oi) \tag{5.18}$$

The question of whether oil revenue is likely to have a positive long-term effect on economic growth can be tested by an econometric analysis including log per capita output, log per capita oil income and total factor productivity. In order to test the effects of oil revenue on output per capita, we enter oil income in the growth function. Therefore, to summarize, replacing A_t by its equivalent from (5.18) in (5.13) we have

$$g = \psi_1 lnA_0 + \psi_2 lnFD + \psi_3 V_t + \psi_4 (FD * oi) + \psi_5 \ln \varphi \left({}^{s}/_{n + \delta} \right) + \psi_7 \ln \left({}^{EX_t}/_{inf} \right) + \psi_8 \ln(P_t^o O_t^o) - \psi_9 lny_0 \tag{5.19}$$

In the above equation, the factor $\left({}^{s}/_{n + \delta} \right)$ has been separated out, becoming an additional variable. Equation (5.19) constitutes the basis of the theoretical framework of this research since it enables the achievement of its general purpose, which is to estimate the impact of oil revenue on the Iranian economy over the period 1955-2014. As previously mentioned in Chapter Three, reviewing the resource curse literature, political economy considerations such as rent-seeking activities and corruption are obviously important. Here we assume they are likely to reveal themselves in the equilibrium level of capital stock and can impact on the steady-state growth of the country.

5.3 Data for Various Variables and Sources

In the literature on natural resources, the most common variables are the ratio of natural resources to GDP, and GDP growth. However, in more recent studies, both of these variables have been criticized and some new variables have been proved to generate different results. The new variables are real output per capita and natural resources export. In addition, some scholars tried to explain the relationship between natural resources and economic growth through other variables, such as institutional quality, political economy, financial development, volatility etc. In this thesis, the following are identified as variables explaining the relationship between natural resources and economic growth.

5.3.1 Real Output per capita

Evidence has proved that, in finding the determining factor of output growth, the outcome can be sensitive to what is employed to measure the level of output (Temple 1999). Unlike most studies, which concentrate on the impact of natural resource abundance on economic growth, this research uses the level of per capita output as the dependent variable. In addition, the study employs a growth accounting framework, where economic growth is used as a measure of economic performance. By economic growth here we mean the level of output per capita. Using the growth rate of GDP as a measure of economic growth in resource curse studies has been subject to criticism on a number of grounds. First of all, the majority of frameworks in the Solow/Ramsey tradition indicate that the influence on growth should be temporary, but could still be perpetual for the level of per capita output. In addition, the rate of growth does not take into account the population of the country. For the aforementioned reasons, this research uses per capita GDP as a measure of economic growth.

The measure of per capita output used in this research corresponds to the purchasing power adjusted values of GDP from version 9 of the Penn World tables. The variable chosen from a number of alternatives in the data source is the calculated output-side at chained PPPs (in mil. 2011 US$) denoted as RGDPE. As is demonstrated in the following figure, output per capita increased significantly in the 1970s due to the spike in oil prices. However, later, in 1979, the economic and political system of Iran changed dramatically due to the Iranian revolution and subsequent eight-year war with her neighbour Iraq. In the 1980s, output per se decreased quite sharply, not only because of the economic consequences of the war and the revolution but also because of the government's policies focusing on encouraging higher population. After 1994, output per capita started increasing slowly, and it continued to increase until 2012, when following new rounds of sanctions imposed on Iran targeting the oil and gas sector output per capita decreased. Figure (5.1) depicts Iran's output per capita in the period 1955-2014. All the fluctuations that were mentioned above can be seen in the figure.

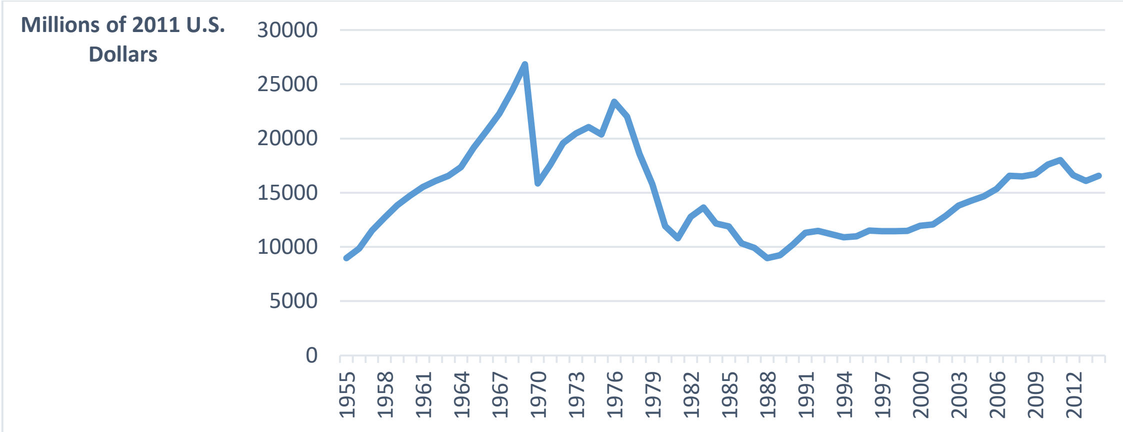


Figure (5.1) Real Output per Capita for Iran (1955-2014).

Source: Penn World tables, version 9, and author's calculation

5.3.2 Inflation

An unstable inflation rate is a signal from prices that indicates the need for stabilization. In other words, stabilization of prices is possible through optimal allocation of resources, which engenders efficiency in the economy. The economic history of Iran shows a relatively high inflation rate of nearly 17 per cent since the revolution. However, this rate of inflation has been officially announced by the Iranian government as being lower than the "real" inflation. Inflation in Iran, like any other key macroeconomic variables, has corresponded to important events such as revolution, war, the 1993 balance-of-payments crisis and sanctions.

Inflation is included in the study to take into account the effects of interest rates as well. Since the interest rate in Iran is not market determined and the credit markets are controlled strictly, inflation is a good proxy for interest rate assuming the Fisher equation holds in the long run (Esfahani et al. 2013). The inflation rate has been calculated by the author through the data collected from the World Bank website on the Consumer Price Index and the Iranian Central Bank. As can be seen from Figure

(5.2b), the rate of inflation in the country is not stable and has fluctuated quite often; furthermore, the alterations in the rate of inflation have been very sharp. Inflation can have significant and wide-ranging impacts on the economy; one of its important impacts is on the exchange rate of the country, which is the next variable.

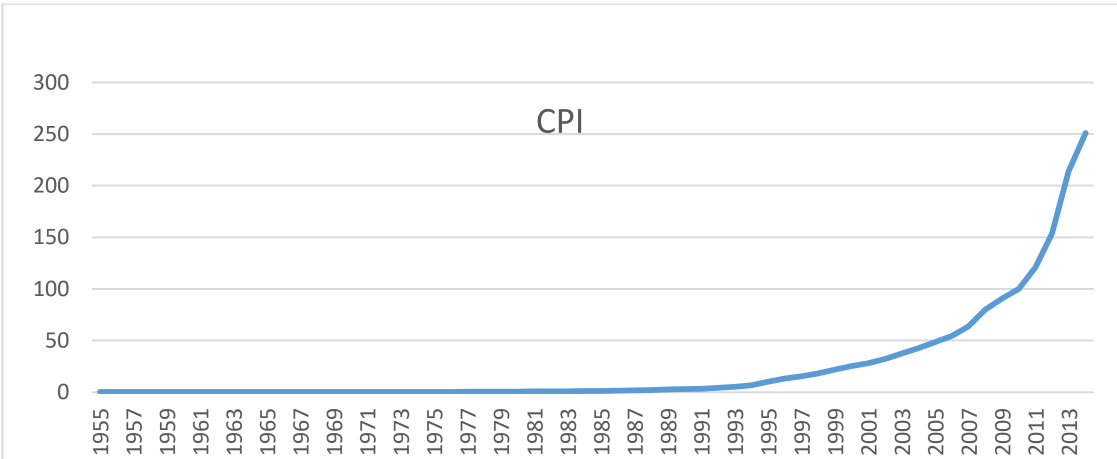


Figure (5.2a) CPI of Iran (1955-2014).

Source: The World Bank and the Iranian central Bank

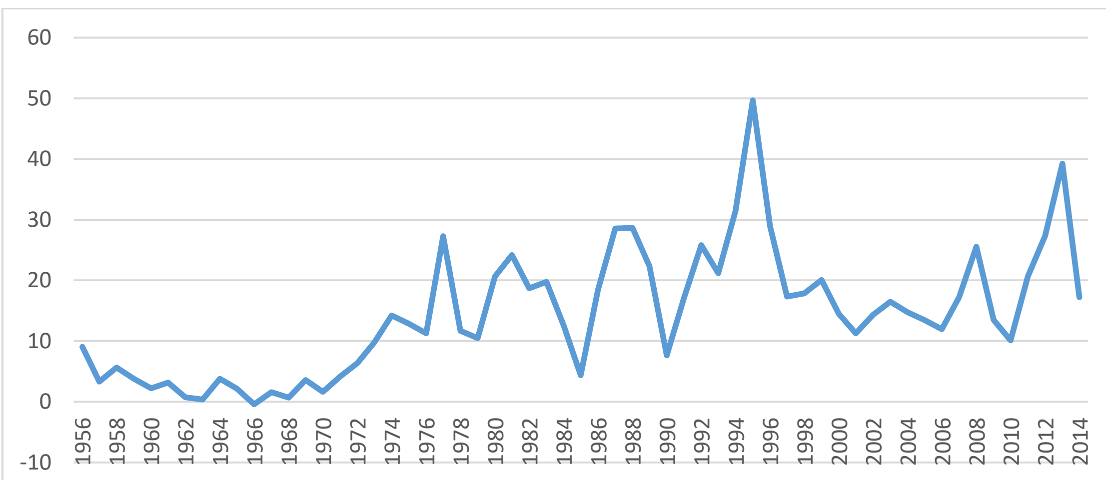


Figure (5.2b) Inflation Rate in Iran (1955-2014).

Source: The World Bank, the Iranian Central Bank and the author’s calculation

5.3.3 Exchange Rate

Referring to the exchange rate in Iran is not easy since apart from the official market there is also a free market for foreign currencies. In the pre-revolution era, there was no free market for an exchange rate. The government provided foreign exchange at the official rate for everyone. By the end of the Iran-Iraq war, Iran had twelve different exchange rates to the US dollar. The endeavour of the government to fight corruption and rent-seeking activities reduced it to four. In the 1990s, it was possible for an importer to benefit from a subsidized official exchange rate 22 times lower than the market rate. This kind of policy created rent-seeking activities such as over-invoice imports or under-invoice exports to engender profits. In March 2002, the reformist government unified the exchange rate; however, the free market rate was different from the official rate.

In 2011, the rial (the Iranian currency) suddenly crashed in the free market. The government's policy was to remove the differences and to have a unified rate in the country, which was not successful and introduced the third exchange rate for travellers between the official and free market. Unsuccessful policies of the Iranian Central Bank and different rounds of sanctions made the situation even worse. The last round of sanctions in December 2011, which involved Iran's Central Bank, burst the exchange rate overnight. As can be seen in Figure (5.3), the rate of exchange started increasing slowly from 1994, but since 2012 and the last round of economic sanctions by the United States and the European Union targeting the oil industry in Iran the country has faced an unprecedented rise in the exchange rate, which is translated into a weaker currency.

It is worth mentioning that the absence of suitable responses to volatility in oil revenues conveys massive volatility in the exchange rate. This has happened in Iran particularly since 1979. Ever since the revolution, the Iranian Rial has been on a downward trend. The data for the exchange rate in this research is obtained from the World Bank.

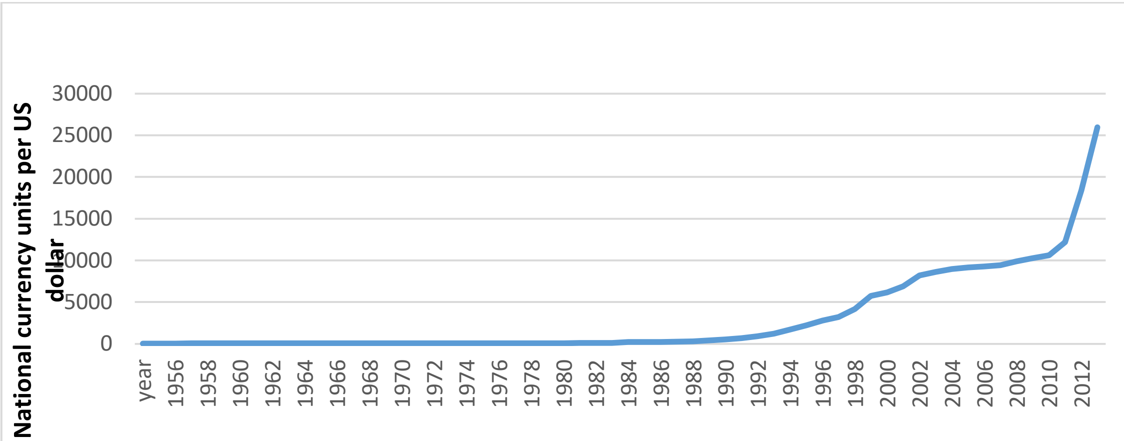


Figure (5.3) Exchange Rate (Market + Estimated) of Iran (1955-2014).

Source: The World Bank

5.3.4 Oil Prices

Figure (4.5) illustrates Iran's crude oil prices from 1955 to 2014. As is obvious in the figure, oil prices were stable as long as they used to be determined by the Seven Sisters Company in the international market and the host countries did not play any role in defining prices. In 1973, the first oil shock happened and this was only the beginning of an unstable market. Most importantly, these ups and downs in oil prices were not predictable. The fact that oil prices are volatile is detrimental to the Iranian economy since the government budget is dependent on oil income enormously. Due to the detrimental effects of volatile oil revenue, some oil exporting countries got together and established a cartel called the 'Organization of Petroleum Exporting

Countries' (OPEC). The main incentive behind establishing OPEC in the 1960s was to stop the reduction of oil incomes for OPEC's members. From 1965 to 1973, the global demand for oil increased. OPEC's members met the main portion of this increase by expanding their productions. In 1973, OAPEC announced an embargo on the US and the Netherland; this action raised oil prices, which was followed by substantial reductions in OPEC's production. The Iranian revolution in 1979 led to another round of oil price spike. Iran was facing so many strikes in its oil sector that the production cutbacks from Iran were about 2 to 2.5 million b/d, and at some point it was almost halted.

Over three decades, after the war, Iran's production was only two-thirds of the level that had been reached under the government of Reza Pahlavi. After higher oil prices, new discoveries started coming online. Oil price experienced some ups and downs but they were not significant enough to influence the world economy significantly until 2008. Another spike in prices occurred in 2008 when the oil market faced high demand due to the global economic growth. This time higher oil prices were not associated with any geopolitical the fact that some oil fields reached maturity quite quickly was part of the reason, but it cannot be the only reason. For instance, oil production from the North Sea was 8 per cent of the global production in 2001, but by the end of 2007 it had decreased to almost 2 million b/d (Hamilton 2011). The unprecedented increase in oil prices in 2008 did not last forever and prices started decreasing by 2009, with prices dropping by almost 48%. After that, prices stayed low and did not undergo a huge increase.

In recent decades, the oil market faced volatility in prices and the era of stability was halted. Despite the fact that 2008 suggests an exceptionally large price fluctuation, volatility in oil prices is normally higher than any other commodity since supply and demand curves are inelastic. Demand is inelastic because there is no substitute for oil in fuel-consuming equipment. The time series highlights prominent volatility during the course of the study with some episodes being very volatile, mainly throughout the Gulf War and financial turbulence. Figure (4.5) demonstrates all the fluctuations in oil prices and illustrates how volatility has developed over time in the oil market. Data on oil prices were collected from the OPEC annual statistical bulletin.

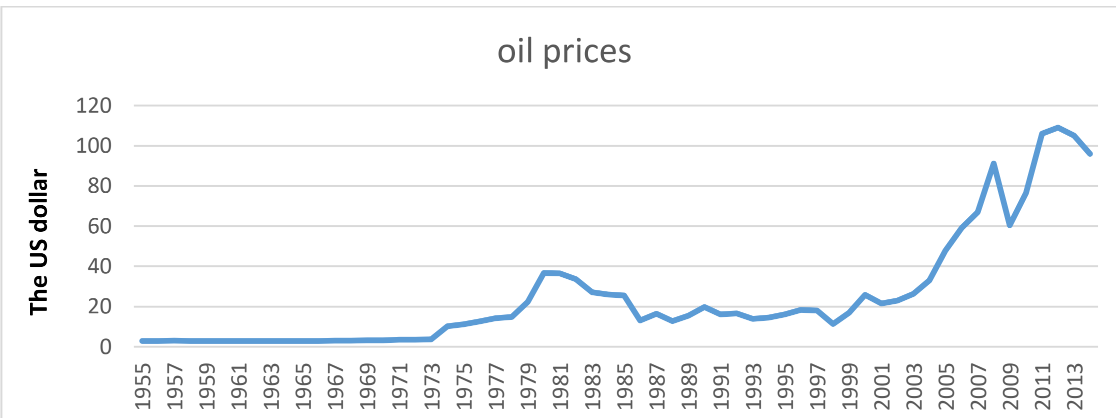


Figure (5.4) Iran's Oil Prices (1955-2014).

Source: OPEC Annual Statistical Bulletin

5.3.5 Oil Production

Figure (5.5) shows Iran's oil production. As is clear from the chart, after the revolution Iran was never successful in reaching the same point of production that she used to produce before the revolution. In 2012, Iran's oil production dropped to one of its lowest levels after the war when the United States and European Union made sanctions tighter, targeting Iran's oil sector. Iran's oil export declined to almost 2.5 million b/d in 2012. Although the world's supply of oil increased in 2012, the oil production in Iran dropped by almost 700,000 b/d. For the first time since 1986, Iraq exceeded Iran's production and Iran was no longer the second-largest oil producing country in OPEC. Data on oil production were collected from OPEC's annual statistical bulletin.

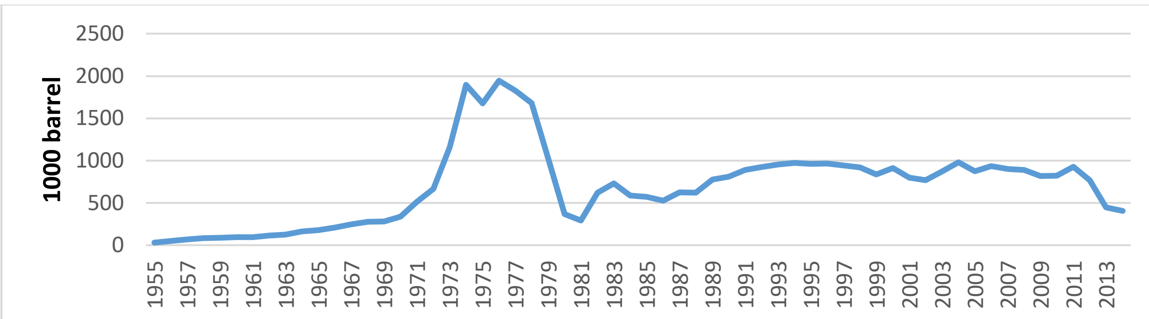


Figure (5.5) Iran's Oil Production (1955-2014).

Source: OPEC Annual Statistical Bulletin

5.3.6 Oil Revenue

Figure (5.6) demonstrates Iran's oil revenue from 1955 to 2014. Oil revenues are likely to have high fluctuations in comparison to other fiscal incomes. There are different reasons for this volatility, such as oil prices, exhaustible resources, the discovery of new oil fields, and changes in demand and other substitutions. Apart from these reasons, oil income originates from abroad and any policies by countries that import oil can have a significant impact on oil revenues. Furthermore, incomes from export have a considerable influence on the real exchange rate contingent on how the inflows of foreign currency are spent.

As can be seen from Figure (5.6), Iran faced fluctuations in her oil income during the war and later a significant drop due to a decrease in oil prices and sanctions imposed on the country because of the nuclear programme. It is important to mention that data on oil revenue in Iran are the data published officially; however, due to the corruption in the system, especially with sanctions, there were a number of embezzlements in the country. Furthermore, no data are available from the oil exported and its income, which have not been recorded officially.

The Iranian economy is highly vulnerable to oil revenue oscillations. Volatility in oil revenue reduces planning horizons since petrodollars are the main source of income for the country. The result is volatile revenues and budget constraints for the government. The government heavily subsidizes energy, and fluctuations in oil revenue make the government budget very tight. Iran only retains a balanced budget with oil prices of between \$90 and \$95 per barrel (Shaffer et al. 2012). However, the Iranian government spends over a quarter of economic output on subsidies for energy. The data on oil income have been calculated by the author according to the following formula.

$$Oi_t = \frac{EX_t\ Oo_t\ P_t}{inf}$$

where EX is the exchange rate, Oo_t is the number of barrels that the country sells, P_t is the price of oil in domestic currency and inf is inflation. Figure (5.6) depicts the history of oil revenue in Iran, which is calculated by the author according to the data collected from OPEC's Annual Statistical Bulletin.

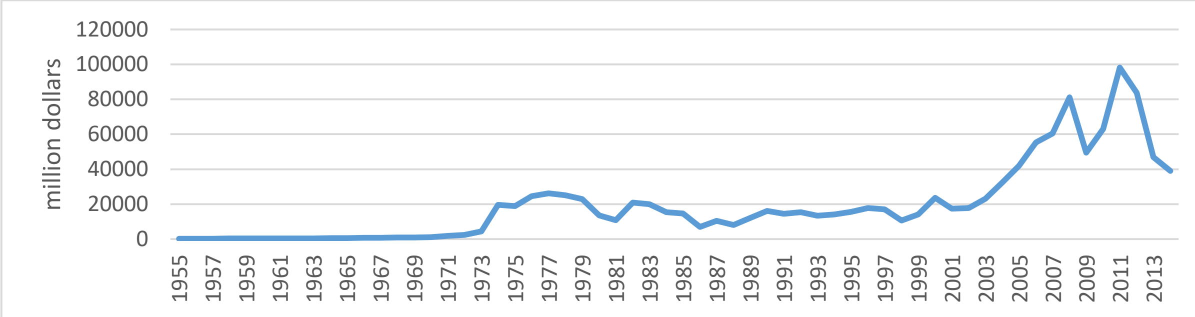


Figure (5.6) Iran's Oil Revenue (1955-2014).

Source: OPEC. Annual Statistical Bulletin and author's calculation

5.3.7 Volatility

In the literature, most of the time oil endowments are blamed for slow economic growth in oil-rich countries. If we put aside differences in the oil producing countries and look at what they all have in common, it is necessary to analyse the oil market. The oil market has changed enormously in the new century, and this alteration affected oil prices significantly. Looking at the last two centuries, two different periods in oil prices can be observed. The first one is oil's "golden era" from 1874 to 1974 when the oil market was stable, although it did not stay stable forever. Ever since the first oil shock, the world has experienced unstable oil prices and the oil market has faced volatility. Consequently, around the same time oil started to play a substantial role in the Iranian economy. Although the price of oil did not stay high forever, its significant role in the Iranian economy did not diminish.

As previously mentioned, from the 1970s onward oil remained an important factor of the Iranian economy and volatility was an inevitable part of it; therefore, this research uses methods employed in finance to take into account the effects of volatility. Nevertheless, the volatility of oil revenue in Iran is not just because of the alteration in oil prices but also because the Iranian revolution, the eight-year war with Iraq and sanctions together generated more uncertainty in the oil revenue of the country. The most recent empirical analysis of the impact of oil revenue on economic growth strongly indicates that in general, oil revenue has a positive role in the development and growth of the Iranian economy (Esfahani et al. (2014); Mohaddes and Pesaran (2013). However, this positive influence has sometimes been exhausted by the negative effects of volatility.

To explore the effects of oil price volatility on the Iranian economy, this research follows the finance literature of Mohaddes and Pesaran (2013) and Andersen et al. (2001) in using realized volatility. Nevertheless, this study uses monthly data on oil prices to calculate annual volatility. The realized oil price volatility is calculated as follows:

First the log returns have been calculated:

$$r_t = \log(P_t) - \log(P_{t-1}) \tag{5.20}$$

The next step is the sum over the past N squared return

$$RV_t = \sum_{i=1}^{N} r_t^2 \tag{5.21}$$

The square root of the realized variance gives us the realized volatility.

$$RVol_t = \sqrt{RV_t} \tag{5.22}$$

Figure (7.5) illustrates the realized volatility of oil prices. The figure indicates that the oil price fluctuation was very small before 1970, which is not surprising at all since before the 1970s oil prices were structured by the key international oil companies. Considerable volatility was first experienced in the first oil shock and then the second oil shock. Ever since the first oil shock, volatility has remained a key feature of the international oil market.

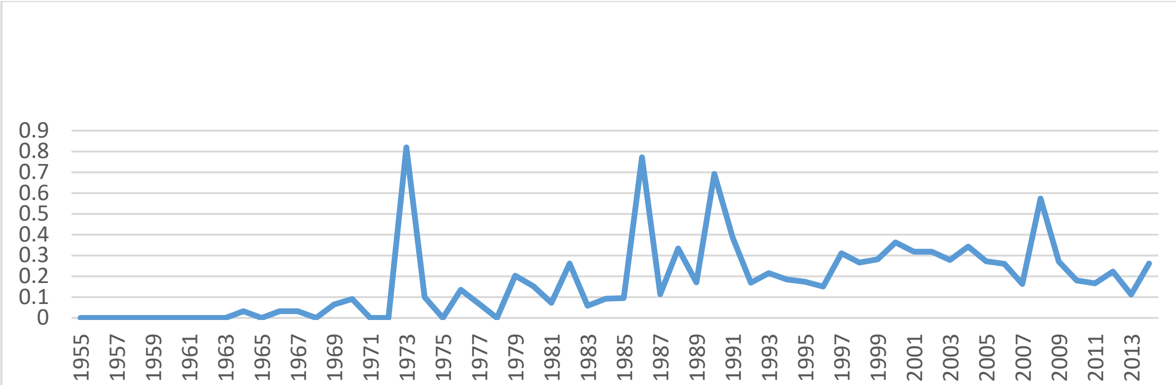


Figure (5.7) Volatility of Iranian Oil Prices (1955-2014).

Source: OPEC. Annual Statistical Bulletin and author's calculation

5.3.8 Financial Development

It is believed that a good financial system and high-quality institutions are essential for using petrodollars for development and economic growth. For instance, Hicks (1969) states that financial development played a key role in igniting industrialization in England by easing the mobilization of capital. Schumpeter (1934) indicates that a financial system assists technological innovation by collecting money (savings), assessing investment projects, observing and making transactions. Since financial systems can obtain detailed information about agents they are authorised means of the country allocating money to entrepreneurs. In other words, the Schumpeterian point of view indicates that the development and improvement of financial intermediaries have a direct effect on productivity and economic growth. Goldsmith (1969) associates economic growth with a financial system and indicates that improvement and development in financial intermediation speeds up economic growth. According to him, the commercial banks were the very first financial intermediaries in the early stages of economic growth. In the next stages other intermediaries, like insurance companies, and formal capital markets, are expanded to facilitate services to special classes of needs. Goldsmith (1969) investigates the link between the size of financial systems (the ratio of the value of intermediary assets to GNP) and economic growth for 35 countries during the period 1960-1963. His results demonstrated that there is a strong positive association between financial intensity and aggregate output, particularly during the times when a financial system is growing fast.

The works by Goldsmith (1969), Diamond (1984), King and Levine (1993a), King and Levine (1993b), Bhattacharya and Sivasubramanian (2003), Gylfason and Zoega (2006) and Nili and Rastad (2007) demonstrate a positive relationship between financial development and economic growth. McKinnon (1973) and Shaw (1973) show in their studies that financial development can influence economic growth in a positive way by increasing saving and capital accumulation.

Von Furstenberg and Fratianni (1996) indicate in their study that the ideal measure of financial development should be a variable that mirrors the alterations in the cost of financial intermediation, which is the outcome of an efficient financial system. One variable that can act as a proxy for the cost of providing financial services is possibly the real interest rate. Although, as previously mentioned, as the interest rate in Iran is not market determined and markets act under tight controls, the interest rate in Iran cannot be a good proxy.

Several indicators can be used to measure the level of financial development for a country like Iran with oil endowments. It is necessary for financial institutions to have the ability to direct the flow of credit to the private sector in resource-rich countries. To take into account the role of financial development here we use the following proxies: the flow of domestic credit to the private sector as a percentage of GDP (PRIVY); financial depth, which is money and quasi money, and has been used widely in the literature; and finally credit, which is domestic credit provided by the banking sector as a percentage of GDP. Since the data on financial development are highly correlated, in this research first we estimate models with each of the proxies and then we use principal component analysis to generate an index out of these three proxies.

5.3.9 Principle Component Analysis

In order to lessen the dimensionality and correlation of the data on financial development, the technique of principal component analysis was employed. Principal component analysis (PCA) involves a mathematical procedure that converts a number of correlated variables into a number of uncorrelated variables called "principal components". The first principal component accounts for the biggest possible variability in the data set, and each subsequent component accounts for the remaining variability of data.

The key objective of principal component analysis is to reduce the dimensionality in data. It is a method that tries to retain all the alteration in data even in a very large data set. It converts the variables into a new variable that can be called "the principal component" and they are not correlated. The maximum deviation of the original variables is included in the first and second principal components (Jolliffe 2002). Principal component analysis is usually applied as an approach to reduce variables in order to detect the structure of the relationship between them. Basically each principal is the weighted average of the underlying variable. The first principal component contains the maximum variance for any of the combinations. Even if more than one principal component is created, they are uncorrelated.

The main strength in generating a financial development index by principal component analysis is that the weight of the index is based on the inner correlation of all the measures. Jackson (2005) stated that principal component analysis is a data analysis approach that obtains linear transformation of a group of correlated variables to achieve certain optimal conditions, the most important of which here is obtaining uncorrelated transformed variables. As mentioned before, in this research principal component analysis was used to generate a single measure of financial development, which is called "FD" in this study. The new index FD index is achieved by computing the eigenvalue of the variance matrix.

5.3.10 Revolution and War

During the time span of this research two main events influenced the Iranian economy and especially the oil revenue of the country. Since these two events had a significant impact on the Iranian economy, they need to be considered in the econometric model; to this end, the econometric framework has a dummy variable. In 1979, the country faced a revolution that dramatically changed both the economic situation and the oil income of the country due to the new policies of the Islamic government. One year after the Iranian revolution, the country went through a war with her neighbour Iraq, which lasted for eight years; since both countries are major oil exporters and they set each other's oil field on fire, oil prices went up significantly. Therefore, both the Iranian economy and the international oil market were affected by this event.

5.3.11 Population Growth Rate

During the past five decades, Iran has witnessed four fundamental reversal in the state's fertility policies. In 1967, the first family plan was set out in order to encourage lower fertility. However, this plan was ended after the Islamic revolution in 1979. Then, for the next 10 years the new government adopted pronatalist policies. Following this in 1989 the government launched another plan in order to control population growth and to lower fertility. In 2010, the country faced low fertility and an aging population, therefore; the chance of fallen population,implying higher chances for a long-term population decrease. As a result the Iranian government again adopt a pronatalist policy in order to encourage a higher population increase.

A sound understanding of Iran's population dynamics is important since the focus of this research is on per-capita output. According to the 2016 census, Iran's population was about 80 million whereas its growth rate fell to 1.2 % annually. This rate is similar to today's world average, however; significantly lower than its peak ever since the revolution. Iran's population increased from 34 million to almost 50 million, corresponding to the growth rate of 3.9% from 1976 to 1986. However, the outcome of the 1996 census demonstrated a significant drop in the population growth rate. The peak of population growth rate in Iran was in 1980 to 1985, which was about 4% per year.

According to Iran's birth registry, the yearly number of births raised from 0.9 million in 1960 to 1.4 million in 1978, however; then abruptly increased to almost 2.5 million in the years after the Islamic revolution. Yet, this was followed by a reverse trend which continued till 2000, when the yearly rate of growth was almost 1.1 million. Following 2000, the number of births has increased. Over the last five years the number of birth is changing around 1.5 million annually and the population has been on an increasing trend.

As seen in equation (5.19), the population growth rate has a negative impact on growth rate. Data on the rate of saving have been collected from the Iranian Central Bank and the World Bank since data are not available on all the years of study on the World Bank website. Also, in the estimation process, the study assumes that δ is equal to 5 per cent per annum. This assumption is very common in the growth literature (Mankiw et al. 1992; Islam 1995; Caselli et al. 1996). In addition, the data on population growth (n) have been collected from the World Bank.

5.4 Quality and Reliability of Data

With any decisions on the course of time and data collection there are strengths and weaknesses. The strength in the data selection is that the data come from official websites: OPEC, the World Bank, the Iranian Central Bank and the Penn World tables. The period of study takes into account major events in the international oil market and the history of Iran, including the Iranian revolution and eight-year war with Iraq. On the other hand, official data in Iran are not a very accurate indicator of the reality: for instance, there is a free market for foreign currency with a very different exchange rate, but there are no reliable data available on that market. In addition, usually the government announces a lower inflation rate to suggest that the economic situation is better than in reality.

Data selected for this study were compared with those from the International Energy Agency (IEA) and the Iranian Central Bank. The results indicated that the figures from different sources are broadly consistent. To achieve the main objective of the study, which is to determine the effect of oil income on economic growth in Iran, it is essential to collect data over a long period as well as seasonal data. However, seasonal data are not available for macroeconomic variables in Iran. This restricted the data of the study.

All the analysis of the data in this research is carried out using EViews software, version 9, and Microsoft Excel software for data management and some basic analysis. Before processing the model estimation, it is essential to recall the significance of choosing the right proxy for studying the role of natural resources and financial development in economic performance. In addition, following the literature, as explained earlier in this chapter, other explanatory variables are also included in the model. For instance, inflation and the exchange rate are used to calculate the real oil income. As a measure of financial development, three different indicators are used: money and quasi money as percentage of GDP; domestic credit provided by the financial sector; and domestic credit to the private sector. The inclusion of volatility captures the fluctuations in the international oil market, which turns out to be important and to have significant effects. Finally, dummy variable captures the impact of important events in the period of study, i.e. the Islamic revolution and eight-year war with Iraq.

Some of the recent literature on natural resource endowments concentrates on political economy considerations, and believes that income from resources creates motivations for rent-seeking activities that generate corruption, voracity and even civil conflicts (see (Mauro 1995; Lane and Tornell 1996; Leite and Weidmann 1999; Collier and Hoeffler 2004)). The model here concentrates on the significance of the effects of variables on the level of real output per capita. In this process political economy and rent-seeking activities are still important and influential. Nevertheless, this study will not address such political economy considerations directly and believes they tend to show themselves in the equilibrium level of capital and steady-state growth of the economy. While this chapter focuses on the significance of the impact of oil income and explanatory variables on the growth, which is subjected to the techniques being utilized, it is difficult to point comfortably to the most appropriate one. Here we quote Kiviet (1995: 72)

"*As yet, no technique is available that has shown uniform superiority in finite samples over a wide range of relevant situations as far as the true parameter values and the further properties of the data generating mechanism are concerned. Perhaps such a technique is just impossible."*

Furthermore, the quality of data is not optimal for Iran as a developing country as considered in this research. As a result, it is possible to bring about an unreliable outcome from quantitative estimations. For instance, in regard to the quality of data on developing countries:

"*Once we go beyond developed nations, the data are of very poor quality (and in many cases non-existent). As discussed in Srinivasan (1994, 1995), most of the data are constructed by interpolation and extrapolation. Summers (Leite and Weidmann 1999) and Heston extrapolated from benchmark countries (which varied from 16 in 1970 to 56 in 1985) to other countries and also from benchmark years (1970, 1975, 1980, 1985)"*

(Maddala and Wu 2000: 641)

Saunders (2011) indicated in his research that there are two main threats to the credibility of research: the validity and reliability of data. In the context of this research there are two main reliability issues. The first issue arises when data are obtained from an untrustworthy source. The second arises if the data released by the national official institutions are the real data. To control the incidence of the first, the data used in this analysis are all obtained from the World Bank Indicators, the Iranian Central Bank, the OPEC website, the Penn World tables and OPEC's annual bulletin. All of these organizations receive data from the primary institutions that generate the data required in this study.

The second problem is unofficial rates and trades that happen in the Iranian economy and these are almost impossible to capture. The researcher is aware that, as in most developing countries, Iranian data are still subject to errors, which, exist to some degree in any data collected. As discussed before, the reliability and validity of data are the key bases of the credibility of a study. Threats to validity in this study may include the accuracy of the specifications of the frameworks and methods, along with the nature of the data employed in the research. Some of the problems could be tackled to some extent by undertaking diagnostic tests and ensuring that the appropriate framework and method are employed to fit the nature of data and to avoid potential threats to the validity of the research outcome. This has been indicated both in the review of literature and in the discussion of the research method and theoretical framework.

In this regard, it is essential to note that some checks on the consistency and reliability of the data were made. However, this study only relies on the official data announced by the Iranian government and is not able to take into account the oil trading that happens unofficially or the exchange rate in the free market. Moreover, the official exchange rate and inflation are different from the reality, but there are no data available for the exchange rate in the free market and the real rate of inflation. In this study, the model nests relevant factors to investigate the role that oil revenue has played in Iran.

It is evident that the empirical studies on natural resources and economic growth have not decisively proved the justification of the so-called resource curse. This calls for clarity on the relationship between oil endowments and economic growth. From an economist's perspective, there are two approaches that are deeply different: the first one begins with a stochastic formulation of time series before decreasing the dynamic by imposing restrictions on the parameters; the second framework begins with a static formulation of a theoretical framework before developing the model with more stochastic components. However, the results of these two approaches vary significantly. To decide on the appropriate econometric estimation, the following section starts with some diagnostic tests on data.

Table 5.1 Variables and Sources

Symbol	Variable	Proxies	Source
Y	Level of per capita output	Economic performance	WDI
EX	Exchange rate	Exchange rate	WDI
INF	Inflation	Inflation	WDI

Credit	Domestic credit provided by financial sector	Financial development	WDI
DEPTH	Money and quasi money as % GDP	Financial development	WDI
PRIVY	Domestic credit to the private sector	Financial development	WDI
O	Oil income	Oil	OPEC
V	Volatility	Fluctuations in the oil market	OPEC and author's calculations

WDI indicates World Development Index

5.5 Data Transformation and Unit Root Tests

In the last three decades, the approaches to estimate econometric models have changed drastically. The standard regression model approach, ordinary least squares (OLS), is based on the assumption of stationary variables. In other words, in order to use OLS the mean and variance of each variable in the model should be constant over time. Yet, most macroeconomic time series variables are non-stationary and show stochastic trend behaviour; therefore, the mean and variance of the series of the variables are non-constant over time. Thus, incorporating non-stationary variables in the OLS method generates misleading outcomes and spurious regression. Even high R^2, DW and significant coefficients can be found where no meaningful association exists among variables.

As was emphasized by Phillips and Perron (1988), estimating regressions with non-stationary variables could have misleading outcomes, illustrating significant associations even where the variables are produced independently. These regressions are known as “spurious regressions” (Patterson 2000), which can happen in models dealing with time series data. The importance of the stationary data in time series lies in the fact that conditions of constant variance, covariance and mean should be satisfied to be able to estimate an accurate model. In order to avoid spurious regression, each individual series needs a careful investigation of the properties of individual series prior to estimation. Graphical inspection can create a general picture of the trend behaviour of the time series, and its difference. Hence, time series plots alone cannot indicate whether a series is stationary or not. Autocorrelation tests can give indications of the integration order of the data; however, they are only correlations. More sophisticated models are pivotal to show the association amongst variables and their lags through regression frameworks.

To achieve this relationship, unit root tests can be used. A unit root test can be applied to decide whether the variables of interest are stationary or not. In order to decide on the order of integration amongst variables in the following section, first we look at the graph of variables and the first difference. Then unit root tests such as the Augmented Dickey-Fuller (ADF), Phillips-Peron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests will be applied.

It is important to mention that all the variables in econometric models apart from volatility and inflation are transformed to log form for a number of reasons. First of all, the natural logarithm transformation is helpful in finding the normal distribution of the data. Moreover, the estimated coefficients in a logarithm-transformed model are the elasticities of the variables in logs; therefore, the findings are easy to interpret since elasticity is unit free. In addition, it reduces the outlier effect. This illustrates the impact of 1 per cent change in a variable on the dependent variable irrespective of the units of each variable (Pindyck and Rubinfeld 1998).

The Augmented Dickey-Fuller, Phillips-Perron and KPSS tests, the last of which was developed by Kwiatkowski et al. (1992), will be applied in this study and a summary of the results is outlined in Tables (5.2) and (5.3) below. The null hypothesis in the Augmented Dickey-Fuller is if the natural logarithm of the variable of the interest has a unit root. The constraint of standard and well-known tests for unit roots like Dickey and Fuller (1979) or Phillips and Perron (1988) is that they do not provide essential information on the nature of the persistence of the time series in the study (Garratt et al. 2012). The results of the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and KPSS tests calculated for the period 1955-2014 for both the levels and first differences of the core variables are shown in Tables (5.2), (5.3) and (5.4).

5.5.1 Augmented Dickey-Fuller Test

The ADF test begins with an autoregressive (AR) (K) framework, where the explanatory variables are dependent lagged k periods. The ADF test corrects for higher-order correlation by presenting lags of first differences of the dependent variables as demonstrated in equation (5.25).

$$\Delta Y_t = \alpha + \delta t + \rho Y_{t-1} + \sum_{i=1}^{k} \gamma_i \, \Delta Y_{t-i} + \varepsilon_t \qquad (5.25)$$

where Y_t is the time series variable at time t, t represents the deterministic time trend, ΔY_{t-i} are the lagged first differences, and α and δ are the parameters that need to be estimated. Equation (5.25) tests to check whether the null hypothesis $H_0; \rho = 0$ of the existence of a unit root is accepted against the alternative of $H_1: \rho < 0$. The test is performed consecutively. The calculated ADF test results are compared to the critical values from the non-standard Dickey-Fuller distribution at the different levels of significance. If the estimated t-statistic of ρ is greater than the critical value in an absolute value, the null hypothesis will be rejected, specifying that the variable is non-stationary in its level. The first difference of the series will be tested following the same procedure. This process will be repeated until a stationary time series is achieved, which determines the order of integration of the data (Lim and McAleer 2001).

5.5.2 Phillips-Perron Test

The Phillips-Perron test builds on the Dickey-Fuller test with the same null hypothesis, which is the existence of the unit root $H_0; \alpha = 0$. However, it suggests a non-parametric approach. As a result, it is applicable to broader categories of time series, including ARMA and moving average models (Phillips and Perron 1988).

$$\Delta Y_t = \alpha Y_{t-1} + u_t \qquad (5.26)$$

where Y_t is a time series and u_t is the error term. Whereas the ADF test addresses the issue of a higher order of autocorrelation by adding lag difference terms of the variable, the PP test changes the test statistic of the α parameter; therefore, serial correlation cannot affect the asymptotic distribution of the statistic (Waheed et al. 2006). The drawback of using a unit root test is that these tests have low power in regard to available sample sizes and time spans.

5.5.3 KPSS Test

In the ADF and PP unit root test the null hypothesis of the time series is I(1). On the other hand, the null hypothesis of the time series is I(0) in stationary tests. The most popular stationary test is the KPSS test, which was proposed by Kwiatkowski et al. (1992). The test was derived from the following model:

$$y_t = \beta' D_t + \mu_t + u_t \tag{5.27}$$

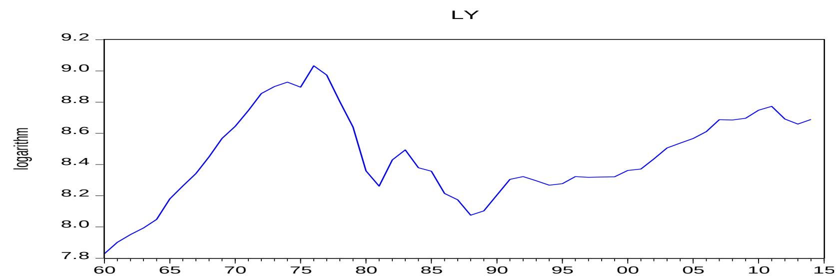
$$\mu_t = \mu_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim WN(0, \sigma_\varepsilon^2)$$

where D_t encompasses deterministic components and u_t is I(0) which may be heteroscedastic. In this test the null hypothesis is y_t is I(0); in other words, H_0: $\sigma_\varepsilon^2 = 0$, which indicates that μ_t is a constant. The KPSS test statistic is the Lagrange Multiplier (LM) or testing for $\sigma_\varepsilon^2 = 0$ against $\sigma_\varepsilon^2 > 0$. In contrast to the two previous tests, here the estimated value should be smaller than the critical value.

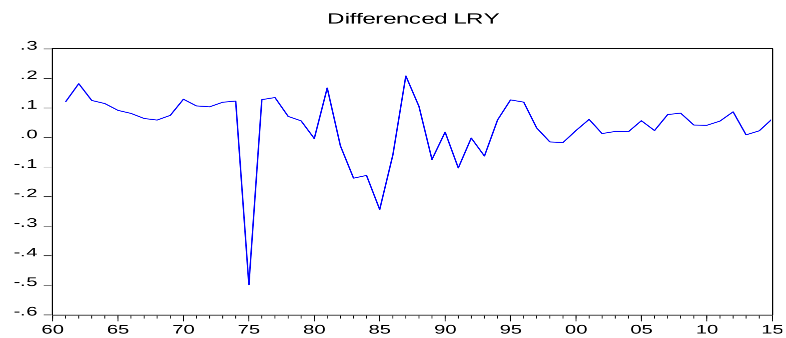
5.5.4 Graphical Investigation

Graphical investigation of all the variables, in levels and first differences, is demonstrated in Figure (5.8) in order to determine whether the data are stationary or non-stationary.

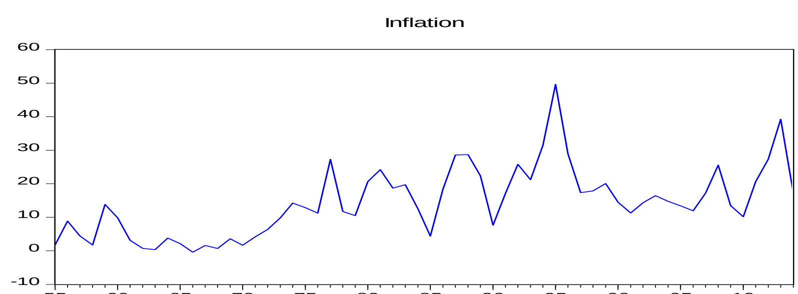
Iran’s real output



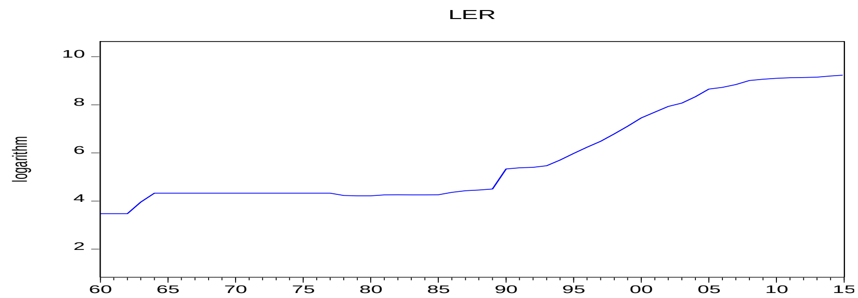
First difference of Iran’s real output



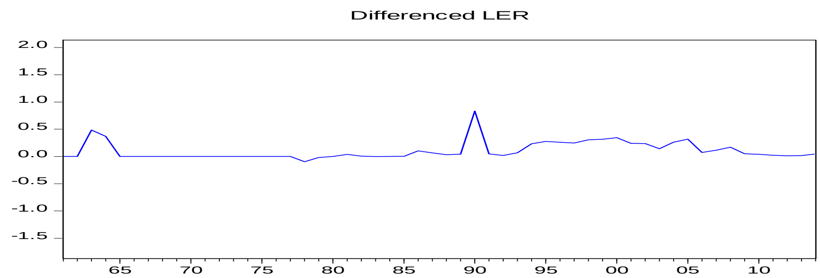
Iran’s inflation



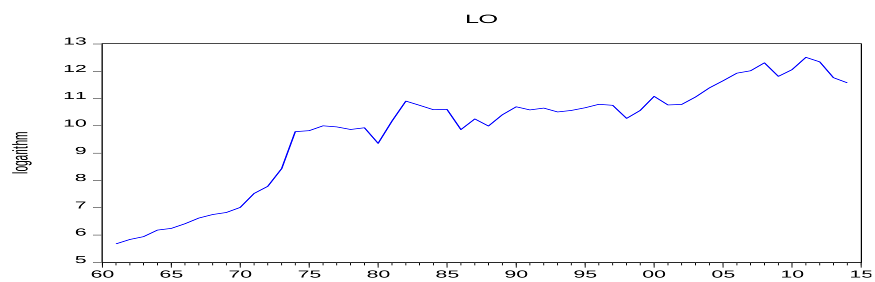
Iran's exchange rate



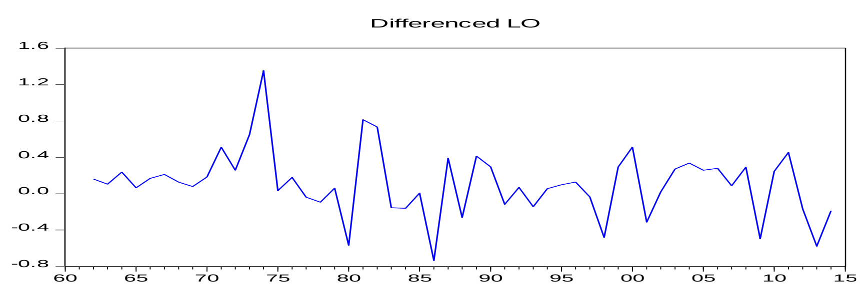
First difference of Iran's Exchange rate



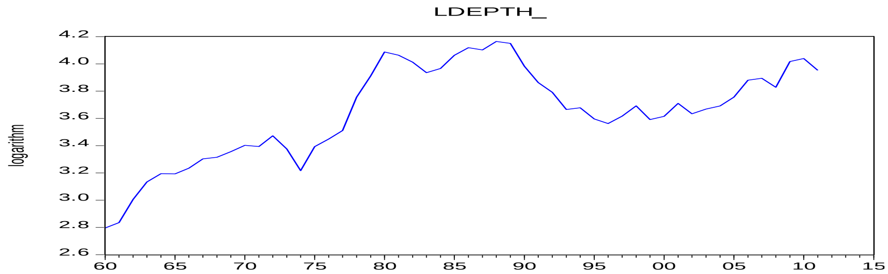
Iran's oil revenue



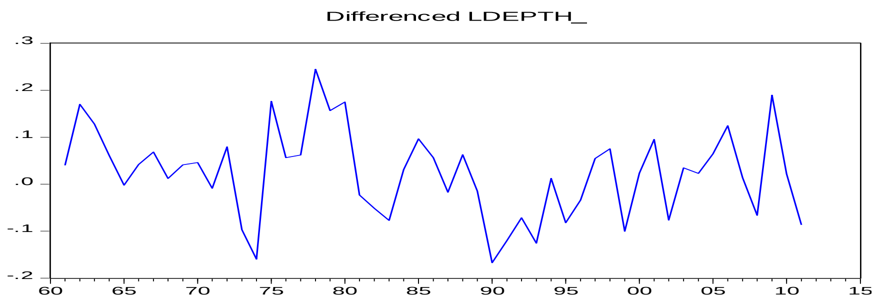
First difference of Iran's oil revenue



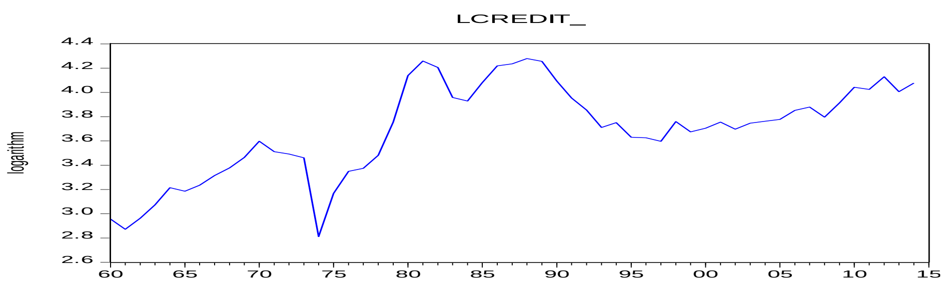
Money and quasi money as % GDP



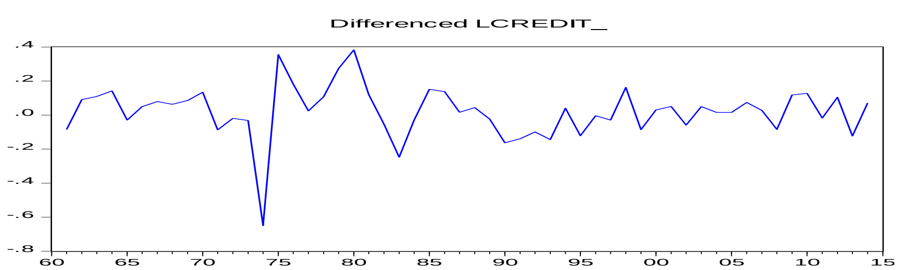
First difference money and quasi money as % GDP



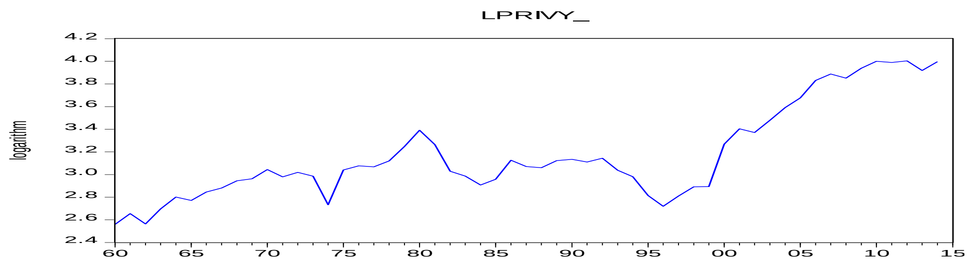
Domestic credit provided by financial sector



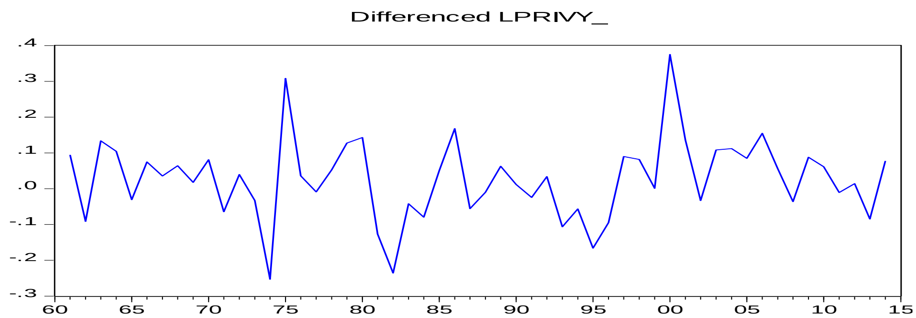
First difference of domestic credit provided by financial sector



Domestic credit to the private sector



First difference of domestic credit to the private sector



Oil price volatility

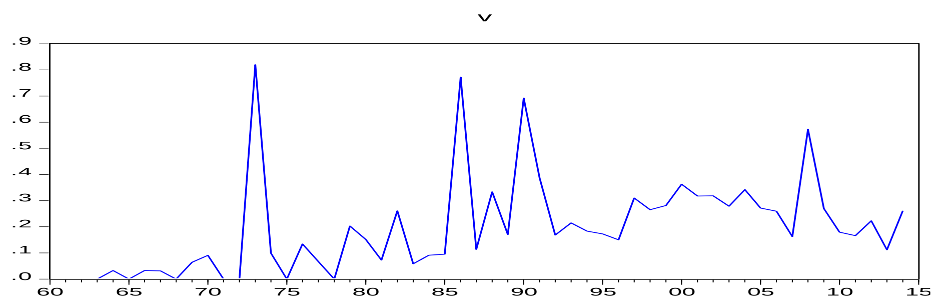


Figure (5.8): Natural Logarithm of the Variables of the Study and their first differences.

As has been demonstrated by the graphs in Figure (5.8), all the variables apart from volatility and inflation have either a deterministic or stochastic trend over time. In the first difference of variables trend behaviour has vanished over time. The figures suggest that all variables apart from volatility and inflation are non-stationary their first difference; however, is stationary.

5.6 Unit Root Test Results

Following the graphical investigation, the time series unit root tests ADF, PP and KPSS were applied on all the variables of the model. Tables (5.2), (5.3) and (5.4) demonstrate that the results of unit root tests for all the variables of interest are less than critical values at 1% and 5% levels apart from volatility and inflation. In other words, the results demonstrate that the variables are stationary at first difference. Because in the results of the ADF, PP and KPSS tests the variables are non-stationary, it is necessary to transform them by taking their first differences in order to achieve stationary data.

Table (5.2) Augmented Dickey-Fuller Unit Root Test Applied to Variables in the Core Model

Variables	Level		First Difference	
	Intercept	**Intercept and trend**	**Intercept**	**Intercept and trend**
Real output	-2.045777	-2.199514	-6.321605	-6.285890
Exchange rate	0.884924	-1.120934	-4.875181	-5.115546
Inflation	-3.433975	-4.2647722		
Oil income	-2.315146	-1.741442	-6.708308	-6.834727
Credit	-1.961882	-2.081161	-6.716695	-6.716019
Depth	-2.177651	-2.116098	-4.798964	-2.600563

Privy	-0.531755	-1.559439	-6.721260	-6.722793
Volatility	-6.138291	-7.369931		

Note: When applied to the levels, ADF statistics are calculated using ADF regression with an intercept ADF(0), a linear time trend and intercept ADF(1) and ρ lagged.

Table (5.3) Phillips and Perron Unit Root Test Applied to Variables in the Core Model

Variables	**Level**		**First Difference**	
	Intercept	**Intercept and trend**	**Intercept**	**Intercept and trend**
Real output	-2.307279	-2.808860	-6.199946	-6.191905
Exchange rate	1.009005	-1.156560	-4.928418	-5.117386
Inflation	-3.282387	-4.225100		
Oil income	-2.261460	-1.892369	-6.699496	-6.828909
Credit	-1.996714	-2.162378	-6.716695	-6.716019
Depth	-2.382729	-2.081868	-5.146104	-5.297989
Privy	-0.683934	-1.691444	-6.722829	-6.694202
Volatility	-6.193432	-7.369931		

Table (5.4) Kwiatkowski-Phillips-Schmidt-Shin Unit Root Test Applied to Variables in the Core Model

Variables	Level		First Difference	
	Intercept	Intercept and trend	Intercept	Intercept and trend
Real output	0.168843	0.137975	0.219593	0.196552
Exchange rate	0.882294	0.2051257	0.358985	0.107759
Inflation	0.717751	0.141626		
Oil income	0.707861	0.160105	0.249938	0.069300
Credit	0.661640	0.136941	0.095729	0.083883
Depth	0.224520	0.089441	0.025944	0.023844
Privy	0.107517	0.082314	0.022835	0.017699
Volatility	0.778853	0.137426		

It has been proved in the literature that the data on natural resources, GDP and most macroeconomic variables are non-stationary. Thus, the mean and variance are not constant; therefore, the assumption of the OLS estimator is violated and the results of regression are likely to be spurious. To solve this problem, researchers employ different variables in order to obtain stationary variables; however, in such a scenario important information in regard to long-term analysis is lost.

It is important to mention that the existence of structural breaks in time series can make the result of the Dickey-Fuller test for integration unreliable. Perron (1989) and Perron and Vogelsang (1992) have indicated that a structural break in the mean of a stationary variable would bias the standard Dickey-Fuller and Augmented Dicky-Fuller tests toward non-rejection of the hypothesis of a unit root. If any structural break exists it could be concluded that the process is I(1) whereas it is I(0). In order to test stationarity despite the structural break the ‘two-stage’ procedure suggested by Perron (1990) was adopted. Initially regression of each series was built on the residuals of single-lag values of variables. The t-ratios were compared with the Perron critical values based on the number of observations and the level of significance. The results indicated that t-values for both time series were higher than the Perron critical values. Therefore it is concluded that all the variables apart from inflation and volatility are non-stationary.

A number of econometric time series methods have been employed in the analysis of natural resource abundance and economic growth. Methods include panel data models (Cavalcanti et al. 2011b), autoregressive distributed lag (ARDL) tests (Jahan-Parvar and Mohammadi 2011), vector autoregressive ordinary least squares, co-integration and the VECM test (Esfahani et al. 2013). Each of these approaches has its own weaknesses that affect the choice of methods; therefore, based on the available data and for how and what the results are intended to be used, approaches are determined and chosen. Nonetheless, some approaches are recognized as being more reliable and less likely to produce spurious outcomes.

Since the model has six variables, there is a chance of having a co-integrating vector among variables. Based on the results of unit root tests, the co-integration relationship between output per capita as a dependent variable and independent variables can be tested. In addition, this method treats all the variables in the system as endogenous; therefore, there is no endogeneity bias if endogenous regressors are included. Moreover, the problem of multicollinearity is minimized in the VECM approach as regressors in the VECM are almost orthogonal. Furthermore, all figures about the long-term effects are present in brief in the levels matrix, which can be used with special attention when the co-integration problem is solved. Finally, the interpretation of the coefficients is more intuitive, since they can be easily categorized into short-term and long-term effects. In addition, because the co-integration method is used in this research the problem of endogeneity is minimized.

The co-integration approach would retain the long-term associations and obtains consistent parameters in the long-term (Stock and Watson 1988). In addition, the associated ECM estimates the short-term dynamics associations and the speed of adjustment to the long-term equilibrium is specified. However, there are a number of restrictions such as order of integration and co-integration tests that need to be satisfied before the estimation. Because of the results of unit root tests, this study is going to use co-integration analysis. This model will take into consideration the time dimension of the study. In addition, the fact that the omitted variables are either constant or change evenly will be captured through the deterministic trend.

It might be asked why, if the study is going to use a co-integration model, we need to include a theoretical part? The answer to this is that not having any background analysis and beginning immediately with the co-integration analysis would raise questions about components included in the model and the rationale behind choosing them. Therefore, this research explained a theoretical framework to clarify the choice of variables. It is worth adding that in this research we are going to apply two methods: first we start with a co-integration approach using ARDL, then we continue with the VECM model.

Some literature assessing the effects of natural resource abundance on economic performance was discussed in Chapter Three. A number of researches focus on the negative short-run impact of a new natural resource discovery on economic growth, while others concentrate on the positive long-term influence of resources. Following the latter, here we continue to estimate the econometrics model given by equation (5.19). The level of financial development and volatility and the interaction between financial development and oil income are included in the model. In order to evaluate the role of the mentioned variables in explaining economic performance we use equation (5.19). From a theoretical point of view, to determine the impact of oil revenue on economic growth, there are many factors that need to be considered. However, it is impossible to take into account all variables simultaneously.

5.7 Conclusion

This chapter presented a theoretical model that is basically a variation of the neoclassical growth model, which includes oil income in the capital accumulation process. The variables were specified for the model for the period 1955-2014. Real output per capita was specified as a dependent variable whereas real oil income per capita, inflation, the exchange rate, volatility, financial development, and the interaction between financial development and oil income were specified as the determinants of output per capita. The definition of the aforementioned variables, the adopted proxies and sources of data were explained in detail.

The properties and the stationary status of the data were examined through graphical inspection and three unit root tests: ADF, PP and KSSP. Consequently, the results for all unit root tests were in line with the literature, which gave us more confidence in the results. All variables are integrated to the order of one except volatility and inflation, which are found to be I(0). Consequently co-integration analysis can be performed.

The best solution to understand growth and investigate the impact of different variables is to examine time series data for each country individually, since countries experience different events, policies, political systems and so many other issues that contribute to economic growth and variations of it. Application of an instrumental variable that fails to address the validity of instruments would undermine the results of regression and the estimated results would be inconsistent. The econometric model would be in line with the theoretical model and would allow us to achieve the main objective of the study, which is to determine the impact of oil revenue on the Iranian economy over the period 1955-2014.

With respect to the estimation process, it is essential to note that there are a few econometric problems in growth literature that need to be dealt with, namely the omitted variables, ignorance of the time dimension and how this study measures economic growth. Co-integration models have outstanding advantages for studying economic growth in comparison to cross-sectional regressions and panel data models. For instance, despite the fact that cross-sectional regressions and panel data are likely to suffer from omitted variables, by using the VAR technique it is possible to control for them. In addition, the use of time series allows one to take into account the time dimension of the study. Moreover, the VAR approach can control the possible problems of endogeneity.

The next chapter estimates co-integration models for this study to obtain the empirical results. The present study attempts to address the resource curse in regard to oil in the Iranian economy by employing the proposed framework. To this end, autoregressive distributed lags and vector error correction techniques based on time series will be used in order to improve the estimated parameters of the role of growth in Iran and produce more accurate results.

Appendix 5

Table (5.5) Annual GDP (billion USD) Data and Population

year	Annual GDP	population
1955	49094.15	18.49558
1956	53554.2	19.00651
1957	62288.37	19.54
1958	70728.28	20.1
1959	79804.8	20.68551
1960	82565.14	21.29356
1961	88173.72	21.9192
1962	95176.59	22.56736
1963	99726.71	23.23508
1964	103487.6	23.9322
1965	119009.8	24.65477
1966	129606.3	25.40476
1967	145270.4	26.1644
1968	160112.4	26.9327
1969	175250.7	27.71558
1970	203657.1	28.51401
1971	230380.6	29.28113
1972	260586.7	30.07385
1973	281535.5	30.90357
1974	284100.3	31.7849
1975	268502.6	32.73056
1976	294777.9	33.73923
1977	264616.9	34.81423
1978	232114.4	35.97759
1979	204493.3	37.25677
1980	118836	38.66822
1981	107412.5	40.20908
1982	146629.1	41.86237
1983	144257.3	43.61051
1984	140961.3	45.42902
1985	144213.4	47.29079
1986	130345.6	49.20558
1987	143338.9	51.15212
1988	127438.4	53.03594
1989	142444.6	54.73524
1990	175121.9	56.1692
1991	205060	57.28804
1992	221581	58.1301

1993	280478	58.81186
1994	293629	59.50129
1995	305672.4	60.31863
1996	366441.9	61.30663
1997	383228.1	62.42609
1998	395292.3	63.61607
1999	433352.3	64.78036
2000	492996.7	65.85006
2001	564511.4	66.81274
2002	659469.4	67.69668
2003	748614.8	68.52207
2004	834729.8	69.32195
2005	976026.1	70.12212
2006	1045916	70.92316
2007	1170065	71.72086
2008	1194807	72.53069
2009	1207749	73.37098
2010	1275174	74.25337
2011	1355094	75.18432
2012	1203364	76.15698
2013	1232942	77.15245
2014	1218374	78.14364

Source: The World Bank

Chapter Six

CO-INTEGRATION AND ERROR CORRECTION ESTIMATION

6.1 Introduction

Chapter Five discussed the theoretical framework of the study by introducing an augmented neoclassical model. On the basis of such a framework, the current chapter aims to estimate an empirical version of the model for the Iranian economy. In other words, it examines empirically the link between oil income and economic growth. The estimated model considers both the long-term equilibrium and the short-term dynamics simultaneously. While the long-term role of oil income is of major importance for policymakers and planners, the short-term dynamics are central for forecasting.

The results of unit root tests in the previous chapter indicate that two variables are integrated of order zero and the rest are integrated of order one, suggesting that the results of OLS estimation could be spurious. Therefore, the study will use co-integration analysis to address different orders of integration in data. In addition, an alternative econometric co-integration approach, Autoregressive Distributed Lag (ARDL), is utilized in this research as well. Following Esfahani et al. (2014), who tested the theory that they developed for major oil exporting countries using VARX and VECM, we test the theory in Chapter Five using ARDL and VECM models. A detailed report on the results from the analysis of the association between oil endowments and economic growth in both models will be carried out for the Iranian economy.

The rest of the chapter is organized as follows: Section 6.2 justifies the econometric method chosen to model the role of oil revenue in the Iranian economy. Section 6.3 discusses the ARDL approach and Section 6.4 the ARDL procedures. Section 6.5 discusses the empirical results of ARDL for the course of the study in the Iranian economy. Following that, Sections 6.6 and 6.7 discuss the vector autoregressive model approach and the procedure of the model before the focus moves on to the empirical results of VECM models in Section 6.8. Finally, a summary of the chapter and concluding remarks are provided in Section 6.9.

6.2 Justifying the Selected Co-integration Approach

Nelson and Plosser (1982) indicate in their work that a significant number of macroeconomic time series have a unit root; therefore, the null hypothesis of no unit root cannot be rejected for the majority of macroeconomic time series.

As Engel and Granger indicate:

"If each element of a vector of time series x_t first achieves stationarity after differencing, but a linear combination $\alpha' x_t$ is already stationary, the time series x_t are said to be co-integrated with co-integrating vector α. There may be several such co-integrating vectors so that α becomes a matrix. Interpreting $\alpha'^{x_t} = 0$ as a long-run equilibrium, co-integration implies that deviations from equilibrium are stationary, with finite variance, even though the series themselves are non-stationary and have infinite variance."

(Engle and Granger 1987: 251)

In other words, this definition indicates that for some non-stationary variables that fit into the same economic system, there might be an attractor that stops them from going away from each other. Therefore, in the equilibrium there is a power forcing variables to move together in the long-term, which is called a "co-integration relationship". Co-integration was introduced in a series of papers by Granger (1983), Granger and Weiss (1983) and Engle and Granger (1987). According to these studies, for the existence of a co-integration relationship, variables should be integrated of order one but the residuals of the linear combination of those variables should be co-integrated of order zero. However, in regard to the order of integration in variables, Pesaran and Shin (1998) and Pesaran et al. (2001) suggested the ARDL method of co-integrating analysis. They believed the system of variables can also be a combination of I(0) and I(1) or only I(0) or I(1) for ARDL estimation. Therefore, according to Pesaran et al. (2001), as long as there is no I(2) variable, a co-integration relationship can exist. Moreover, if there are n variables in the model, up to $(n-1)$ co-integrating relations can exist.

Different co-integration modelling approaches are used for time series analysis, with the most common techniques being the two-step approach originated by Engle and Granger (1987) and the maximum likelihood approach suggested by Johansen (1988). Johansen's method has a number of advantages over the Engle-Granger method. For instance, Johansen offers a greater clarity on the statistical significance tests on the speed of adjustment and also it can identify multiple co-integration relationships. It is worth mentioning that although all the variables are considered endogenous in the VAR model, which can be estimated as a co-integrated VECM, the model still allows for weakly exogenous variables.

According to Johansen's approach, all the variables should have the same lag lengths. However, the proposed ARDL model for co-integration by Pesaran et al. (2001) can override this issue for models whose regressors have different lag lengths. Moreover, the ARDL bound test method has established a strong ability to handle fairly small samples. In addition, endogenous variables would not hamper the model's ability to produce unbiased estimates of the long-term parameters.

This chapter uses the single-equation, Autoregressive Distributed Lag (ARDL) bound test approach to co-integration according to Pesaran et al. (2001) Model to evaluate the long-term equilibrium and the short-term dynamic associations within the output per capita oil income nexus. There is limited evidence in the literature on growth and natural resources of comprehensive use of the ARDL bound test approach to co-integration. Thus this research fills this gap by introducing an important contribution to the empirical literature that concerns both the short-term and long-term associations between oil income and economic performance, represented by output per capita.

In addition, this chapter applies the unrestricted error correction form of the ARDL framework to evaluate the long-term elasticities of variables before using a restricted error correction model (ECM) to estimate the short-term elasticities. This approach to co-integration analysis is suitable for handling variables that exhibit various statistical profiles, such as variables that do not have the same order of integration or variables that have endogenous properties.

Therefore, the ARDL model will be used to test the long-term relationship between output per capita, oil income, financial development and a dummy variable. In general, four ARDL models will be estimated using different indexes for financial development. The first model uses depth as an index of financial development, the second model uses credit as an index, the third one uses PRIVY and the last ARDL model uses principal component analysis to provide a new index using credit, depth and PRIVY[1].

In order to check whether the same result is held by applying another co-integration technique we use a vector error correction model. Four different VECMs will be estimated for testing the co-integration relationship between output, oil income, financial development and the interaction between financial development and oil income, as was explained in the theoretical framework. In addition, the VECM model includes volatility in oil prices as a weakly exogenous variable to check the impact of volatility. In line with the ARDL model, the effects of the eight-year war with Iraq and the Iranian revolution will be taken into account as a political crisis in a dummy variable.

6.3 The Autoregressive Distributed Lag (ARDL) Approach

Here we follow Pesaran et al. (2001) approach to the ARDL model in order to estimate the long-term relationship between variables of the study. As discussed earlier, the variables can be I (0) or I (1) or even a combination of I (0) and I (1). Although regression models of this type have been used for a long time, more recently they have been shown to generate a valuable tool for testing the existence of the long-term associations amongst economic variables. Considering the low power of a unit root test for time series, particularly in small samples, ARDL seems a suitable approach since it does not need a prior unit root test. Moreover, another advantage of the ARDL model, as mentioned earlier, is the fact that it allows a different number of lags for any regressor (Feridun 2010). It is worth mentioning that

[1] As explained in Chapter Five.

the Monte Carlo findings specify that the ARDL method also works accurately when the model has endogenous regressors.

6.4 The ARDL Approach's Procedures

To start the ARDL we go back to a general autoregressive distributed lag model, which is written as:

$$\beta(L)y_t = \beta_0 + \theta(L)x_t + u_t \tag{6.1}$$

where $\beta(L)$ is an order-p that has roots lying outside the unit circle; in other words, they have unit roots and $\theta(L)$ is an order-q polynomial. A basic form of ARDL can be written as:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \cdots + \beta_p y_{t-p} + \alpha_0 x_t + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \cdots + \alpha_q x_{t-q} + \varepsilon_t \tag{6.2}$$

Model (6.2) is autoregressive in the sense that y_t is explained by lagged values of itself. In addition, it has a distributed lag component in the form of explanatory variables x.

There are a number of steps in the ARDL approach to co-integration. First, according to Pesaran et al. (2001), all the variables in the model should be either I(0) or I(1). Therefore, there should not be any I(2) variables since such data will invalidate this methodology. Second, an unrestricted error correction model (ECM) needs to be formulated and the appropriate lag structure for the model needs to be determined. In the following step, the error terms of the model should be checked to make sure they are serially independent and the model is dynamically stable. The next step is performing the bound test to check for the long-term associations between the variables. Then, if the bound test confirms the existence of a long-term relationship, both the long-term model and a restricted ECM can be estimated. Finally, the short-term dynamic effects and the long-term relationships among variables can be measured.

It can be concluded that the ARDL approach is an OLS regression that contains lags that are distributed amongst both dependent and independent variables. The model is presented in the (p, q) set-up. In the model p expresses the maximum number of lags for the dependent variable and $q = q_1, \dots, q_k$ exhibits the maximum number of lags of k independent variables. According to Patterson (2000:349) representation, the overall formula of a multivariate ARDL model is:

$$Y_t = \alpha_0 + \sum_{i=1}^{p} \beta_i L^i Y_t + \sum_{j=0}^{q} \gamma_{ij} L^{ij} X'_t + \varepsilon_t \qquad (6.3)$$

where L is the lag operator and X' is a vector of independent variables. A vector of X' could include variables that have lag of zero.

The first step of ARDL was described in Chapter Five; the result indicates that none of the variable is I(2), which is in line with the first assumption of the ARDL approach. Following that, the appropriate values for the maximum lags need to be selected. The optimal lags are determined according to AIC and SC information. Then, before moving to the bound test, it is important to check whether the errors are independent since one of the important assumptions in the bound test proposed by Pesaran et al. (2001) is that the errors of the estimation must be serially independent.

The relationship between variables in equation (5.19) follows a time path before reaching the long-term relationship. Therefore, equation (5.19) can be written in the following unrestricted error correction form of the ARDL model (taking out volatility and the interaction between oil income and financial development, which are taken into account through total factor productivity):

$$\Delta \ln y_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta \ln y_{t-i} + \sum_{i=0}^{q} \beta_{2i} \Delta lnoi_{t-i} + \sum_{i=0}^{q} \beta_{3i} \Delta lne/inf_{t-i} + \sum_{i=0}^{q} \beta_{4i}\, fd_{t-i} +$$

$$\gamma_1 \ln y_{t-1} + \gamma_2 lnOI_{t-1} + \gamma_3 ln \frac{e}{inf}_{t-1} + \gamma_4 lnfd_{t-1} + e_{1t} \qquad (6.4)$$

where e_{1t} is the error term. The left-hand side of the equation (6.4) is the real output per capita in Iran. The right-hand side of the equation denotes other variables in lags, and in differences. The F-statistic is employed to test the joint significance of the lag levels of the variables in the unrestricted error correction model and specifies the presence of long-term equilibrium under the null hypothesis of no co-integration $(H_0 = \gamma_1 = \gamma_2 = \gamma_3 = 0)$ against the alternative of $(H_1 = \gamma_1 = \gamma_2 = \gamma_3 \neq 0)$ in equation (6.4). However, as argued by Pesaran et al. (2001), none of the statistics has standard distribution, regardless of whether the regressors are all I(0) or I(1) or mutually co-integrated. Hence, Pesaran et al. (2001) calculated two forms of asymptotic critical values for a given significant level in cases with and without trend.

The first considers all the variables as I(1) while the other one considers all the variables as I(0). If the calculated F-statistics are greater than the upper critical value, the null is rejected, which means the variables are co-integrated. On the other hand, if the F-statistics are smaller than the lower critical value, the null cannot be rejected; therefore, the variables are not co-integrated. The last scenario is if the F-statistic value lies between the two bounds, the test is indecisive and needs further investigation. It is important to mention that these critical values are determined by the number of regressors and whether the ARDL framework has intercept, or trend and intercept together. Following the long-term relationship estimation using the bound test, the long-term and short-term associations can be estimated.

After establishing the long-term association in the initial step using the bound test, the long-term coefficients of the co-integrating model will be estimated in equation (6.4). The final stage includes estimating the short-term coefficients from the restricted error correction in equation (6.5). In order to do so, the optimal number of lags for all variables in the ARDL model will be selected according to the appropriate information criteria. Following that, the ARDL (p, q, m, n) as in equation (6.5) will be estimated as:

$$\Delta \ln y_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta \ln y_{t-i} + \sum_{i=0}^{q} \beta_{2i} \Delta \ln oi_{t-i} + \sum_{i=0}^{m} \beta_{3i} \Delta \ln \frac{e}{inf}_{t-i} + \sum_{i=1}^{n} \beta_{4i} \Delta \ln fd_{t-i} + \varphi \varepsilon c_{t-1} + \upsilon_t \qquad (6.5)$$

where εc_{t-1} is the lagged error correction term achieved from the residuals of the prior ARDL model, and φ is the speed of adjustment parameter that congregates the ECM to its long-term equilibrium.

6.5 Empirical Results of the ARDL Models

Annual data over the course of 1955-2014 are used to estimate the long-term relationship between oil income and economic growth in Iran using Pesaran et al. (2001) ARDL approach. We apply ARDL co-integration regardless of the order of integration. For the optimal lag length, AIC criteria will be used since SC tends to choose a simpler model specification than that of AIC. Although there is a risk of overfitting the model, we do not want to underfit it; therefore, AIC seems a better choice. A dummy variable is added due to the political crisis in Iran from 1979 to

1988, which had significant effects both on oil income and the level of output per capita. The political crisis started with the Iranian revolution in 1979, and this was followed by a war with Iraq that lasted for eight years. Since the war and revolution had similar effects on oil production, and also as they were consecutive events, we take their impact into account in one dummy variable. Before checking the bound test it is important to check that the errors of the model are serially independent, otherwise the parameter estimates will not be consistent. To this end, we check the Q-statistics. The P-values strongly suggest that there is no evidence of autocorrelation in the model's residual (results in Appendix 6).

Four different cases were estimated for the ARDL model since we have different indexes for financial development. Case 1 (1, 0, 0, 4) includes output per capita, real oil income, and depth as an index for financial development. Case 2 (1, 0, 0, 1) includes output per capita, real oil income, and credit as an index for financial development. In the third case (1, 4, 4, 0) we used PRIVY as an index for financial development and the rest of the variables were similar to the previous model. The final case (1, 4, 4, 1) includes output per capita, real oil income, and an index for financial development calculated using the principal component analysis method using credit, depth and PRIVY for financial development.

6.5.1 Bound Test

The results of the bound test for the first model indicate that there is a long-term relationship amongst the variables of the study at 5 per cent and 10 per cent significance. Accordingly, we reject the null hypothesis of "no long-term relationship". In line with the first model, the results of the bound test for the second model show there is a co-integration relationship at 5 per cent and 10 per cent significance. In the third case, the relationship only exists at 10 per cent significance. In addition, for the final model the long-term relationship exists only at 10 per cent significance. This means that we reject the null hypothesis of no co-integration, at 5 per cent and 10 per cent for the first and second model and at 10 per cent for the third and last model. Cases 1 and 2 demonstrate the strongest proof of co-integration. In general, the outcome confirms that there is evidence of a long-term co-integration association amongst the variables for all cases, as is depicted in Table (6.1).

Table (6.1) Results of Bounds Test for ARDL Model

Model		10%	5%	1%	F-Stat	Result
Case 1 ARDL (1, 0, 0, 4)	I(0)	2.01	2.45	3.42	3.8006	Co-integrated at 5% and 10%
Lny, lnoi, lne/inf, lndepth	I(1)	3.1	3.63	4.84		
Case 2 ARDL (1, 0, 0, 1)	I(0)	2.01	2.45	3.42	4.1407	Co-integrated at 5% and 10%
Lny, lnoi, lne/inf, lncredit	I(1)	3.1	3.63	4.84		
Case 3 ARDL (1, 4, 4, 0)	I(0)	2.97	3.38	4.3	4.1402	Co-integrated at 10%
Lny, lnoi, lne/inf, lPRIVY	I(1)	3.74	4.23	5.23		
Case 4 ARDL (1, 4, 4, 1)	I(0)	2.97	3.38	4.3	3.79302	Co-integrated at 10%
Lny, lnoi, lne/inf, lnfd	I(1)	3.74	4.23	5.23		

6.5.2 The Long-term Relationships

Table (6.2) demonstrated the long-run relationship amongst the variables of the study. It can be concluded that in the first model, oil income has a significant and positive impact on the level of output per capita. In addition, two important political events (war and revolution), which were captured by a dummy variable, have a significant negative impact on output per capita of the country. According to the results, the depth index, which is money and quasi money as a percentage of GDP, does not have a significant impact on the output of Iran. It can be concluded that the reason for this insignificant impact of depth is the underdeveloped financial system in Iran, which has not been successful. It could be concluded that the Iranian banking system is not capable of attracting savings, which means the country does not have the ability to provide funding for long-run investment.

In the second case, where credit is an index of financial development as demonstrated in Table (6.2), oil income has a positive and very significant impact on output per capita. As expected, the dummy variable has a negative impact on the economy. In addition, credit that is domestic credit provided by the financial sector does not have a significant impact, which can be explained like the result of depth on output per capita. In other words, local banks are not successful in providing loans to the private sector since it does not contribute to economic growth positively.

According to the third model, there is not really a significant relationship among variables. This can be explained by the inefficient financial system (PRIVY) of the country, particularly in terms of domestic credit to the private sector. PRIVY demonstrates the process of allocating loans among the public and private sectors in Iran. Moreover, the dummy variable again shows a significant negative impact on our dependent variable. However, financial development does not seem to have a significant impact, which is in contrast to the growth literature.

The final model considers a new index for financial development that takes into account depth, credit and PRIVY. This new index has been calculated using a principal component analysis approach. The results indicate that in general oil has a positive impact on output per capita, although it could be concluded that the poor domestic credit given to the private sector is a trade-off against the positive impact of oil income.

Overall, it can be said that oil revenue has a positive impact on the level of output per capita in the economy. However, including PRIVY in the model makes the positive impact of oil revenue vanish. Therefore, it could be concluded that in the Iranian economy, in contrast to the common literature, the financial system does not contribute positively to economic growth. Nonetheless, it can be concluded that the reason for the insignificant financial development is underdevelopment and the isolation of the financial system from the rest of the world.

Table (6.2) Results of Long-run Relationship for ARDL Model

variable	Case 1	P-Values	Case 2	P-Values	Case3	P-Values	Case 4	P-Values
Lnoi	0.67227	0.0000***	0.17628	0.0000***	-0.2381	0.1299	0.2565	0.0297
Lne/inf	1.45247	0.0000***	0.95999	0.0000***	0.10757	0.7138	0.0038	0.9895
dummy	-1.7055	0.0043***	-0.7149	0.0331***	-0.6967	0.0139**	-0.7000	0.0247**
ldepth	-0.9250	0.6947						
lcredit			0.54550	0.1141				
lPRIVY					-0.71897	0.2313		
lnfd							0.2074	0.5757

Author's own calculations using Eviews. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

6.5.3 Co-integration

The results of co-integration are demonstrated in Table (6.3). The outcome indicates that there is a long-term equilibrium relationship between output per capita and oil income. As the results indicate, for the first model a 10 per cent change in oil income will result in a long-term change of 7 per cent in output per capita, which is significant. Moreover, in the long term the error correction coefficient for the first model is negative (-0.1082), as required, and is very significant (3.597). The speed of adjustment indicates that the half lifetime of the deviation from the equilibrium would be one year and six months. Equation (6.6) demonstrates the long-term relationship between the variables for the first case.

$$lny = 0.672lnoi + 1.4525\ lne/inf + 0.925LnDepth - 1.705dummy \qquad (6.6)$$

As expected, the error correction term in the second model is negative (-0.099), and the T-statistic is fairly significant (3.542), confirming that there is a co-integration relationship among the variables. The speed of adjustment indicates that the half lifetime of the deviation from the equilibrium would be one year and seven months. As the outcome shows, a 10 per cent change in oil income will result in a long-term change of 5 per cent in output per capita.

The co-integration equation will be as follows:

$$lny = 0.4972lnoi + 1.392lne/inf + 0.545\ LnCredit - 1.372Dummy \qquad (6.7)$$

In the third model, as we expected, the error correction term is negative (-0.2364) and the T-statistic is (5.3188), which is very significant, confirming the long-term relationship. The speed of adjustment shows that the half lifetime of the deviation from the equilibrium would be seven months, which is a fairly quick adjustment. As the outcome shows, a 10 per cent change in oil income will result in a long-term change of 2 per cent in output per capita. The co-integration equation will be as follows:

$$lny = 0.2381lnoi + 1.076\ lne/inf + 0.719\ LnPRIVY - 0.6968\ dummy \qquad (6.8)$$

Finally, in the last model, as expected, the error correction is negative (-0.256), and the T-statistic is very significant (5.396). In other words, the outcome indicates that there is a long-term equilibrium relationship between output per capita and oil income. As the results indicate, a 10 per cent change in oil income will result in a long-term change of 3 per cent in output per capita. The speed of adjustment indicates that the half lifetime of the deviation from the equilibrium would be seven months.

$$lny = 0.2566lnoi + 0.0039\ lne/inf - 0.2074\ lnfd - 0.7001Dummy \qquad (6.9)$$

It is worth mentioning that in general the Iranian economy adjusts quite fast to changes, which can be explained by the restrictions in Iran’s financial system.

Table (6.3) Co-integration Relationships

Variables	Case 1	P-value	Case 2	P-value	Case 3	P-value	Case 4	P-value
dloi	0.08224	0.0453**	0.0874	0.0239**	0.08422	0.0187**	0.1096	0.0021***
dlne/inf	0.1676	0.051**	0.15238	0.0458**	-0.0179	0.8123	-0.0857	0.0013***
dummy	-0.1879	0.0000***	-0.1420	0.0000***	-0.1642	0.000***	-0.1683	0.0000****
CointEq(-1)	-0.1082	0.0009***	-0.0993	0.0009***	-0.2364	0.0000***	-0.2506	0.0000****
dldepth	-0.4719	0.0080***						
dldepth(-1)	-0.5509	0.0047***						
dldepth(-2)	-0.3547	0.0391***						
Dldepth(-3)	-0.5953	0.0093***						
dlcredit			-0.2135	0.0223**				
dlprivy					-0.2484	0.0079***		
dloi(-1)					0.13323	0.0015***	0.1236	0.0017***
dloi(-2)					0.05903	0.1050*	0.07847	0.0299**
dloi(-3)					0.10400	0.0083**	0.1195	0.0043**
dle/inf (-1)					-0.0444	0.5795	-0.0721	0.0574**
dle/inf (-2)					-1.1150	0.1333	-0.1154	0.0136**
dle/inf (-3)					-0.2378	0.0044**	-0.2120	0.0085**
dlnfd							-0.0115	0.7814

*, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table (6.4) summarizes the goodness of fit and diagnosis of four ARDL models. According to the outcome, the R^2 and $Adj\ R^2$ are reasonably high and DW is close to 2 for all the models, which is preferable.

Table (6.4) Goodness of Fit & Diagnosis of ARDL Models

	Case 1	Case 2	Case 3	Case 4
R^2	0.9306	0.94547	0.93642	0.9370
$Adj\ R^2$	0.9519	0.93979	0.91360	0.91217
$Log\ likelihood$	53.1797	58.1134	68.6931	68.9511
DW	1.9549	1.7056	2.12873	2.2539
AIC	-1.8799	-1.9301	-1.98863	-1.9611
SC	-1.52507	-1.7091	-1.43613	-1.3718

6.5.4 Diagnostic and Stability Test

The CUSUM test was performed on the residuals of the ARDL models to test the robustness of the models and the reliability of their estimates. This is essential since the presence of irrelevant variables or the exclusion of main variables or data could create estimation issues such as inefficient estimates coupled with high parameter variability and incorrect standard errors of coefficients and T-statistics. These challenges could exist with a high R^2 and even strong statistical significance within a model. The results for the stability test (CUSUM) indicate that all models are stable since the blue line is inside the red line. (Results for serially independent errors and optimal lags can be found in Appendix 6.)

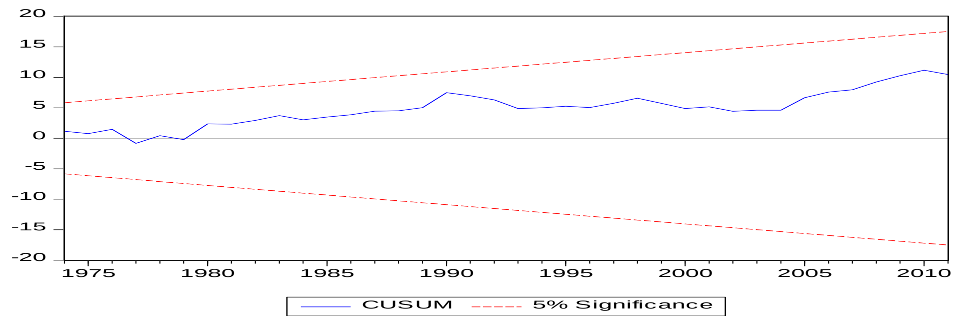


Figure (6.1) Plot of CUSUM Case 1

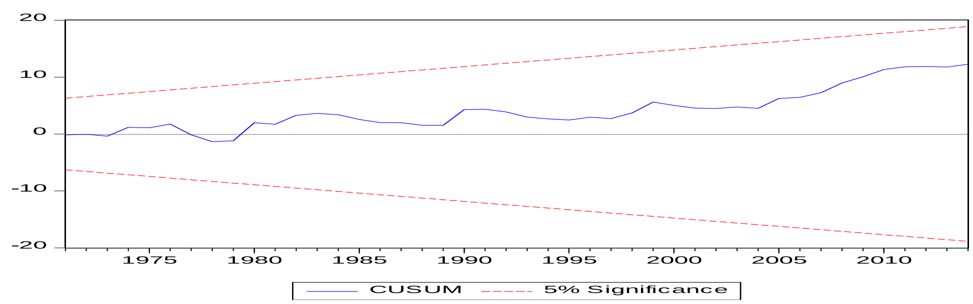


Figure (6.2) Plot of CUSUM Case 2

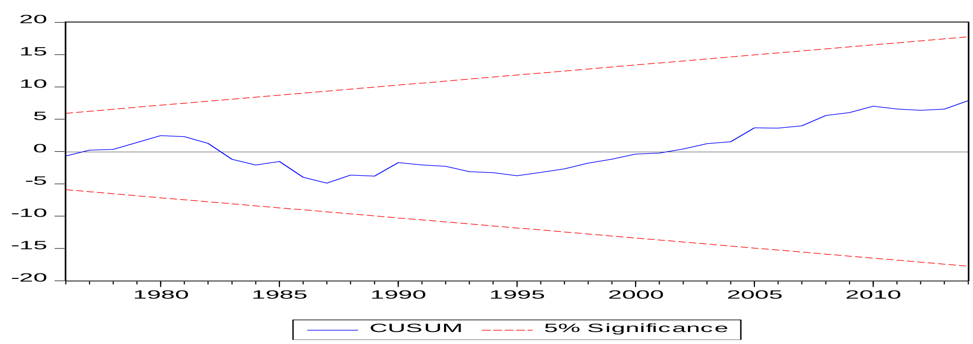


Figure (6.3) Plot of CUSUM Case 3

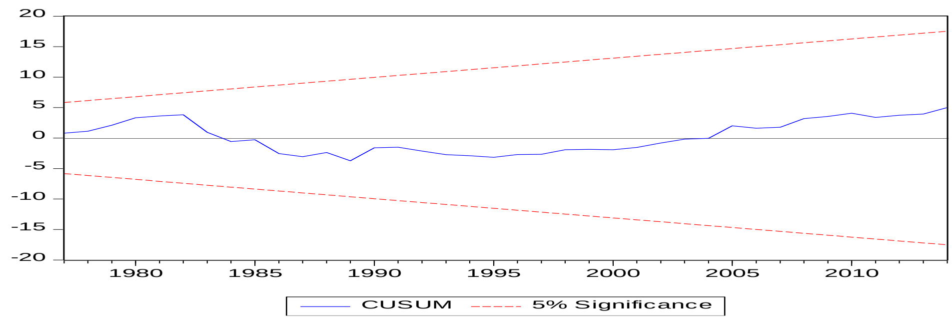


Figure (6.4) Plot of CUSUM Case 4

Overall, it can be concluded that all ARDL models that have been estimated indicate that there is a long-run and positive impact between oil income and output per capita in Iran apart from in model 3. However, in all models financial development seems to have no role in economic growth, which is in contrast to the growth literature, although this may be a symptom of the underdeveloped and inefficient financial system in Iran. Needless to say, ever since the revolution Iran has been under sanctions from the US, and since 2002 more sanctions have been imposed on the country. One consequence of economic sanctions is the isolation of the country and a financial system that does not contribute to economic growth.

6.6 Vector Autoregressive Models

The connection between empirical results and economic theory is at the heart of econometric modelling. Econometric modelling is performed using a variety of techniques, which vary from large frameworks with plenty of equations to a single-equation framework that concentrates on the influence of a handful of variables. Christopher Sims (1980) introduced the vector autoregressive (VAR) approach in macroeconomic modelling; he criticized econometric approaches due to unjustified restrictions imposed on the short-term dynamics, and he suggested an alternative, which is usually termed “a-theoretical” vector autoregression. The VAR model, built on Gaussian (normally distributed) errors, has been a common choice as an explanation of macroeconomic time series data. The statistical foundation of the VAR framework is the Wold decomposition theorem. Sims argued that all variables in the model could be considered endogenous. As he explains, a VAR approach treats all variables simultaneously equal. Furthermore, in a VAR model each variable will be regressed on both its own lags and the lags of the other variables in a finite order system. The aim of this approach is to investigate the dynamic reaction of the system without relying on the “incredible identification restriction” existing in a structural framework.

In general, according to Sims, an unrestricted vector autoregression of order p ($VAR(p)$) is:

$$z_t = C + \sum_{i=1}^{p} \mathrm{A}_i z_{t-i} + e_t \qquad (6.10)$$

where a polynomial matrix $\mathrm{A(L)}$=$B(L)^{-1}$ is the lag operator, $z_t = [z_{1t}, z_{2t}, \dots, z_{nt}]'$ is $I(0)$, and C is an $n_\psi \times 1$ deterministic vector that encompasses a constant, a linear term, dummies or any other variables that are non-stochastic. Although a VAR model does not need strong restrictions and identification assumptions, useful applications of the estimates, such as impulse response functions or variance decompositions, do need their restrictions to be identified. Needless to say, the VAR process has many advantages, such as being flexible and easy to estimate, and most of the time it gives a good fit of data.

According to the traditional VAR framework, variables would not be classified as endogenous or exogenous. Usually it is assumed that all variables are treated as endogenous, but this is not always the case. In macroeconomic models, sometimes the variables of the study are best thought of as exogenous, and that could determine how the VAR model can be articulated. One example of this is in a small open economy where there are foreign variables that influence the domestic variables, but foreign variables are not affected by the domestic ones: for instance, a foreign variable that is determined by its own lag values and not the lag values of the domestic one. Therefore, zero restrictions will be imposed on the B in a VAR model. This structure leads to the VARX framework, where X indicates there is a VAR with weakly exogenous variables. This kind of VAR allows either one or more variables to be treated as exogenous compared to other sets of variables.

The first assumption of VAR models is that all the variables in the model are stationary $I(0)$. In other words, all roots of variables lie inside the unit circle. However, most of the macroeconomic data violate this assumption. The most popular solution for non-stationary variables is differencing. The problem with this solution is that in a VAR framework estimated with differences, some data will be lost by converting non-stationary to stationary data as a result of differencing and the co-integration is ignored. According to Hamilton (1994), one solution is to ignore the non-stationary data and estimate the VAR in levels, relying instead on T standard and F distribution for interpreting the results. The other alternative is to difference the non-stationary data before running the model. The differencing should improve the small sample if the true process is a VAR in differences (Hamilton 1994).

Another solution in the case of VAR if all variables are I(1) individually and a linear combination of the variables is I(0) is that a restricted version of the model that is a co-integration approach will be employed such as a vector error correction (VECM). In co-integration estimations the long-term relationship of variables is examined through co-integration analysis. Hamilton (1994) indicated that in this situation a VAR in difference form is misspecified. Therefore, it is recommended to use Johansen and Juselius (1990) test; the maximum eigenvalue and the trace are both utilized not only to check for co-integration, but also to decide on the number of co-integrations. In addition, the advantages of unrestricted VAR in analysing the impulse response function in co-integrated systems has been emphasized by Naka and Tufte (1997). They indicated that estimation of a co-integrated system is a better idea either as a VAR in levels or as VECM, which is a restricted version of VAR. If co-integration exists, imposing restrictions will result in a more efficient model. Although in the short run, co-integration models are less accurate than VAR models, their Monte Carlo examination demonstrates that the loss of efficiency from the VAR model is not significant in the short-term.

Rewriting the VAR model as a VECM, we have:

$$\Delta z_t = C + \Pi z_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta z_{t-i} + \varepsilon_t \tag{6.11}$$

where

$$\Pi = \sum_{i=1}^{p} A_i - I \quad \text{and} \quad \Gamma = -\sum_{j=i+1}^{p} A_j \tag{6.12}$$

where I_K establishes an identity matrix of the order $K \times K$. If the K vector of variables of z_t is integrated of order one, then the long-term co-integration vector in coefficient matrix Π must be integrated of order zero in order for ε_t to be the error term. The assumption that z_t is $I(1)$ in (6.10) imposes a restriction on matrix Π. In other words, the econometric model of a vector autoregression explains the representation z_t as a function of its own lags and other variables' lags included in the model. This method was criticized for being more theoretical than practical since it relies more on statistical properties than economic theory. Therefore, the restricted VAR (p) can be rewritten as co-integrating transformation, Johansen decomposition, ARDL and VECM. The co-integration approach combines the long-term behaviour of the data and their short-term interactions; hence it can better show the association between variables.

Engle and Granger (1987) showed that if the vector z_t in equation (6.10) is integrated of order one, the coefficient matrix Π rank should be between 0 and k $(0 \leq \mathrm{r} \leq \mathrm{k})$. In other words, the rank of matrix (r) is the number of co-integration vectors in the model. Π can be explained as $\Pi = \alpha\beta'$ where α is the speed of adjustment matrix and β can be defined as the parameters of co-integration vectors. For instance, if z_t consists of five variables and $r = 1$, then vector α and β are 5×1. In other words, there are five adjustment parameters for any of the five equations, and in order to correspond to deviations from the long-term equilibrium associations they are multiplied by the co-integration vector.

6.7 VECM Procedure

There are a number of steps to be performed in order to estimate co-integrating relationships in a VECM approach. In addition, following the VARX models here we consider volatility as a weakly exogenous variable.

6.7.1 Selecting the Optimal Lag

In order to select the appropriate lag order it is essential to obtain Gaussian error terms. To do so, the VAR model with maximum lag length needs to be estimated for non-normality, heteroscedasticity and autocorrelation. In doing so, the lag length is decreased by one lag until zero lags has been reached. In addition, the VAR framework will be re-estimated and the errors will be checked. Then the lag with Gaussian error terms is the optimal lag (Asteriou and Hall 2007). In this research, AIC, SC, and HQ are calculated for each lag and the one with the lowest value is considered the optimal lag.

6.7.2 Deterministic Components

The next required step of the process is to specify whether the model has only an intercept, or trend and intercept or none in the VAR or in the co-integrating equation. The following equation shows the VECM model with different cases that can be considered in a co-integration relationship. The equation (6.13) can have five different scenarios, which are explained in I to V.

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \cdots + \Gamma_{k-1} \Delta Z_{t-k-1} + \alpha \begin{pmatrix} \beta \\ \mu_1 \\ \delta_1 \end{pmatrix} (Z_{t-1} \quad 1 \quad t) + \mu_2 + \delta_2 t + u_t$$

(6.13)

I) There is no intercept or trend in the long-term (CE) or in the short-term VAR; therefore, the model is the most restrictive. In other words: $\mu_1 = \mu_2 = \delta_1 = \delta_2 = 0$. This model suggests that there is no deterministic component in data, which is unlikely to happen in reality.

II) There is an intercept in the long-term but no intercept or trend in the short term; therefore $\mu_2 = \delta_1 = \delta_2 = 0$. This can be translated to no linear trend in data.

III) Both the short-term and the long-term have an intercept but no trend. In other words, $\delta_1 = \delta_2 = 0$. This means there is a linear trend in the levels of data; therefore, it allows the non-stationary association in the model to drift.

IV) Both the long-term and short-term have an intercept; in addition, there is a linear trend in the long-term, where $\delta_2 = 0$. This happens when no quadratic trend exists in the levels of the data. Consequently, there is no trend in the short-term; however, there is some long-term linear growth, which the model cannot account for.

V) Both the CE and VAR have an intercept and trend; however, the trend in the CE is quadratic and the trend in the VAR is linear. As a result, everything is unrestricted in this model. However, it is difficult to justify this model economically, particularly since the variables are in natural logarithm form (Asteriou and Hall 2011).

It is not easy to specify which case is suitable for the data of this research. The graphs in the previous chapter can provide some helpful information on the trend components in our time series.

6.7.3 Checking the Co-integration and Determining the Rank of Π

There are two methods through which the rank of Π can be determined: a trace test and the maximum eigenvalue test of Johansen and Juselius (1990).

I) Trace Test

The null hypothesis in the Trace test is that the number of co-integrating vectors is less than or equal to r. It is considered that r is an indicator of reduced rank in $(n - r)$, where n is the number of variables.

II) Maximum Eigenvalue Test

The null hypothesis here is that the rank $\Pi = \mathrm{r}$, or in other words, there are up to r co-integrating vectors against the alternative, which is the rank of $r + 1$. As a result, the null hypothesis of $r = 0$ is tested against $r = 1$, then $r = 1$ against $r = 2$ and so on.

6.7.4 Imposing Restrictions on $\boldsymbol{\beta_s}$ to Identify Co-integration Vector

After selecting the optimal lag and determining the number of co-integrating vectors amongst the variables in the system, the unrestricted model can be estimated. However, these estimates are sometimes difficult to interpret economically since matrices α and β are not exclusively identified with restrictions; thus, an issue of identification arises (Zhou et al. 2007). Therefore, it is necessary to test for identification in order to formulate a unique co-integrating vector. In order to impose restrictions, prior economic information about the association amongst variables is needed. However, this is not easy as the number of variables that can enter the model should be limited to simplify the co-integration relationship, while according to theory there are many relevant variables.

According to Pesaran et al. (2001), in order to identify a system with a co-integration rank, it is essential to either have r restrictions for the whole system or r number of restrictions for each co-integrating vector. A statistical method was suggested by

Johansen (1988) to impose identification restrictions; however, Pesaran and Shin (1998) state that this method overlooks the theoretical and empirical associations amongst variables and is a pure mathematical convenience. Therefore, they proposed applying economic theory and pertinent prior information to select the long-term identifying restrictions, which is a theory-based approach (Zhou et al. 2007). However, if there is only one co-integration relationship, there is no need for further restriction.

6.7.5 Weakly Exogenous Variable

A variable is a weakly exogenous variable if it is a function of lagged variables and the parameters of the equation that generates that variable are not dependent on the parameters generating the rest of the variables in the system. Such a variable can be removed as an endogenous variable from the left-hand side of the model.

The speed of adjustment to the long-term equilibrium is signified by matrix α in $\Pi = \alpha\beta'$, and β' is the matrix of the long-term coefficients. In order to test for the weakly exogenous variable in the model, the null hypothesis of $H_0: \alpha_{ij} = 0$ for $j = 1, \ldots, r$ needs to be tested. If any of the variables are weakly exogenous when estimating the co-integration vector, the responding element α should be very low. The likelihood ratio test can also be used for the validity of these restrictions. It is important to mention that a VECM model with weakly exogenous variables confirms that the rest of the model has better stochastic properties in regard to having short-term residuals without diagnostic problems.

6.7.6 Impulse Response Function

By using the impulse response function a detailed analysis of the dynamic properties of the VAR framework will be provided. The impulse response function is a standard means of analysing the dynamics in a model. Impulse response analysis can trace the effects of an exogenous shock or innovation in one of the variables, in some or in all of the variables. There are two kinds of shocks to both observable and unobservable variables. The first step of any analysis should definitely be the impact of a shock on the variables. Shocks to observables are analysed by applying generalized impulse response functions (GIRFs). The calculation of GIRFs does not need any identifying assumptions; rather it uses error covariance to allow for the simultaneous linkages that have dominated among shocks historically.

6.8 Empirical Results

In this section, we derive an econometric formulation for our model based on economic theory. For empirical purposes, a log-linear approximation of long-run equilibrium relationships will be discussed. All variables are treated as endogenous, apart from volatility, which is a weakly exogenous variable. The VAR will be estimated as follows:

$$Y_t = C + \sum_{i=1}^{p} A_i Y_{t-i} + BD_t + \varepsilon_t \tag{6.14}$$

where the dependent variable is output per capita, and explanatory variables are real oil income, financial development, and the interaction between financial development and oil income, and we have volatility as a weakly exogenous variable. Similarly to the ARDL model, the Iranian political crisis is taken into account through a dummy variable. Since the co-integration results could not reject the null hypothesis of no co-integration, the VAR system will be transformed to a VEC model as follows:

$$\Delta Y_t = C + \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Pi_i \, \Delta Y_{t-i} + BD_t + \varepsilon_t \qquad (6.15)$$

A vector of variables (real output per capita, real oil income, financial development, the interaction between financial development and oil income and volatility) was tested for the co-integration relationship. Following that a model was estimated that represented the economic performance of Iran over the period 1955-2014 using VECM. It is desirable that all variables are integrated of order one for applying this approach. Nevertheless, unit root tests usually suffer from low power; thus, in empirical work, it is common to test co-integration amongst variables even when some variables are not I(1). Furthermore, Enders (2004) proposed that Johansen's co-integration can be tested for variables with different orders of integration. It has also been suggested that the result of co-integration is valid in the case of mixed integration order of variables (Foon Tang 2011).

In this research, as was indicated in the previous chapter, all variables except volatility and inflation were integrated of order one. Four different VECMs will be estimated using real output, oil income, financial development (four different proxies similar to ARDL models), the interaction between oil income and financial development, and volatility as a weakly exogenous variable. It is important to mention that, similarly to the previous models, the political crisis of Iran will be taken into account via a dummy variable. The first VECM considers depth as a financial development proxy, the second one considers credit, the third one uses PRIVY and the last one uses an index generated by principal component analysis using depth, credit and PRIVY.

6.8.1 Selecting the Optimal Lag Order

The first pre-estimation test for our model is the estimation of an unrestricted VAR to determine the optimal p lag order, signified as VAR (p). As Lütkepohl (2005) showed, the selection of an overfitted VAR would result in the mean square error forecast being inferior to forecasts from an accurate VAR (p), whereas an underfitted VAR would create autocorrelated residuals. Applying the optimal lag length criterion, both the AIC and SC suggest lag one as the optimal lag for all four models, as displayed in the Tables (6.5), (6.6), (6.7) and (6.8).

Table (6.5) Optimal Lag Length VECM 1

Lag length	AIC	SC	HQ
1	-5.985807*	-4.804862**	-5.541409*
2	-5.922001	-3.756935	-5.107272
3	-5.469555	-2.320367	-4.284494
4	-5.647003	-1.513694	-4.091611

* indicates the optimal lag order.

Table (6.6) Optimal Lag Length VECM 2

Lag length	AIC	SC	HQ
1	-2.940443*	-2.182864*	-2.650949*
2	-2.819706	-1.456064	-2.298618
3	-2.556732	-0.587028	-1.804050
4	-2.601290	-0.025522	-1.617013

*indicates the optimal lag order.

Table (6.7) Optimal Lag Length VECM 3

Lag length	AIC	SC	HQ
1	-5.874662*	-4.727448*	-5.437796*
2	-5.655264	-3.552039	-4.854344
3	-5.569119	-2.509882	-4.404144
4	-5.262795	-1.247547	-3.733766

*indicates the optimal lag order.

Table (6.8) Optimal Lag Length VECM 4

Lag length	AIC	SC	HQ
1	-4.042984*	-2.906616*	-3.608744*
2	-3.869324	-1.785982	-3.073217
3	-3.368458	-0.338143	-2.210485
4	-3.772146	0.205142	-2.252307

*indicates the optimal lag order.

Following the selection of lags we need to test for co-integration relationship using Johansen. As was discussed earlier, the rank of the coefficient matrix Π depends on the number of eigenvalues within $\widehat{\Pi}$. The eigenvalues are classified in descending order. In other words, the null hypothesis of no co-integration is tested against at least one co-integration. In the case of the rejection of this hypothesis, the test goes to the next largest eigenvalue and continues until the null cannot be rejected anymore. Tables (6.9) – (6.16) provide brief results for Johansen's test for both the trace and maximum eigenvalue at the first lag.

The outcome indicates the presence of one co-integration vector for all models. In other words, there are dynamic long-term relationships, including the indicators of economic growth and other variables in the study. The maximum eigenvalue and statistical outcome results from the co-integration framework indicate that the null hypothesis of no co-integration at 5 per cent can be rejected and there is no rejection of the null hypothesis for the "at most 1" row. The max statistics demonstrate similar results to the trace statistic concerning the rejection of the null hypothesis of no co-integration at the 5 per cent level and no rejection of the hypothesis at most 1. The trend specification for each co-integration test is selected in line with economic theory and graphical analysis. According to these criteria, the trend specification for our model is based on case 3, which is unrestricted intercept.

Table (6.9) Co-integration Rank Test Statistic for the Core Model (Trace Statistic) VECM 1

H_0	H_1	$Trace\ Statistic$	0.05
$r = 0$	$r = 1$	66.03389*	55.24578
$r \leq 1$	$r = 2$	34.25065	35.01090
$r \leq 2$	$r = 3$	12.90817	18.39771
$r \leq 3$	$r = 4$	6.453911	12.49467
$r \leq 4$	$r = 5$	2.311753	3.841466

Trace test indicates 1 co-integrating eqn at the 0.05 level.
*denotes a rejection of the null hypothesis of the corresponding co-integration rank.

Table (6.10) Co-integration Rank Test Statistic for the Core Model (Maximum Eigenvalue) VECM1

H_0	H_1	$Maximun\ Eigenvalu$	0.05
$r = 0$	$r = 1$	31.78325*	30.81507
$r \leq 1$	$r = 2$	21.34247	24.25202
$r \leq 2$	$r = 3$	10.59642	17.14769
$r \leq 3$	$r = 4$	5.278832	10.49456
$r \leq 4$	$r = 5$	2.311753	3.841466

Trace test indicates 1 co-integrating eqn at the 0.05 level.
*denotes a rejection of the null hypothesis of the corresponding co-integration rank.

Table (6.11) Co-integration Rank Test Statistic for the Core Model (Trace Statistic) VECM 2

H_0	H_1	$Trace\ Statistic$	0.05
$r = 0$	$r = 1$	69.60699*	60.06141
$r \leq 1$	$r = 2$	36.29569	40.17493
$r \leq 2$	$r = 3$	17.62899	24.27596
$r \leq 3$	$r = 4$	2.064739	12.32090
$r \leq 4$	$r = 5$	0.074351	4.129906

Trace test indicates 1 co-integrating eqn at the 0.05 level.
*denotes a rejection of the null hypothesis of the corresponding co-integration rank.

Table (6.12) Co-integration Rank Test Statistic for the Core Model (Maximum Eigenvalue) VECM 2

H_0	H_1	$Maximun\ Eigenvalu$	0.05
$r = 0$	$r = 1$	33.31130*	30.43961
$r \leq 1$	$r = 2$	18.66669	24.15921
$r \leq 2$	$r = 3$	15.56425	17.79730
$r \leq 3$	$r = 4$	1.990388	11.22480
$r \leq 4$	$r = 5$	0.074351	4.129906

Trace test indicates 1 co-integrating eqn at the 0.05 level.
*denotes a rejection of the null hypothesis of the corresponding co-integration rank.

Table (6.13) Co-integration Rank Test Statistic for the Core Model (Trace Statistic) VECM 3

H_0	H_1	$Trace\ Statistic$	0.05
$r = 0$	$r = 1$	94.18857*	76.97277
$r \leq 1$	$r = 2$	48.39903	54.07904
$r \leq 2$	$r = 3$	26.57386	35.19257
$r \leq 3$	$r = 4$	12.42239	20.26184
$r \leq 4$	$r = 5$	1.913236	9.164546

Trace test indicates 1 co-integrating eqn at the 0.05 level.
*denotes a rejection of the null hypothesis of the corresponding co-integration rank.

Table (6.14) Co-integration Rank Test Statistic for the Core Model (Maximum Eigenvalue) VECM 3

H_0	H_1	$Maximun\ Eigenvalu$	0.05
$r = 0$	$r = 1$	45.78954*	34.80587
$r \leq 1$	$r = 2$	21.82517	28.58808
$r \leq 2$	$r = 3$	14.15147	22.29962
$r \leq 3$	$r = 4$	10.50916	15.89210
$r \leq 4$	$r = 5$	1.913236	9.164546

Trace test indicates 1 co-integrating eqn at the 0.05 level.
*denotes a rejection of the null hypothesis of the corresponding co-integration rank.

Table (6.15) Co-integration Rank Test Statistic for the Core Model (Trace Statistic) VECM 4

H_0	H_1	$Trace\ Statistic$	0.05
$r = 0$	$r = 1$	71.16357*	60.06141
$r \leq 1$	$r = 2$	35.34581	40.17493
$r \leq 2$	$r = 3$	15.21184	24.27596
$r \leq 3$	$r = 4$	4.822174	12.32090
$r \leq 4$	$r = 5$	0.894095	4.129906

Trace test indicates 1 co-integration eqn at the 0.05 level.
*denotes a rejection of the null hypothesis of the corresponding co-integration rank.

Table (6.16) Co-integration Rank Test Statistic for the Core Model (Maximum Eigenvalue) VECM 4

H_0	H_1	Max-Eigen Statistic	0.05 Critical value
$r = 0$	$r = 1$	35.81776*	30.43961
$r \leq 1$	$r = 2$	20.13397	24.15921
$r \leq 2$	$r = 3$	10.38966	17.79730
$r \leq 3$	$r = 4$	3.928079	11.22480
$r \leq 4$	$r = 5$	0.894095	4.129906

Max-eigenvalue test indicates 1 co-integration eqn at the 0.05 level.
*denotes a rejection of the null hypothesis of the corresponding co-integration rank.

6.8.2 Identifying the Co-integration Vectors

According to theory, it is expected for volatility to be a weakly exogenous variable. In order to test this for our models we impose the restriction of $\alpha = 0$. The result indicates significant p-value, confirming that volatility is a weakly exogenous variable. The findings confirm that the problem of identification does not hold in this model since volatility is found to be exogenous, considering economic growth as a dependent variable. Consequently, since volatility is considered to be exogenous, the estimation will be valid and overcome the problem of identification and simultaneity. Recalling (5.19), we will estimate the long-term and the co-integration relationship.

$$lny_t = c_1 + \beta_{12} lnoi + \beta_{13} lnfd + \beta_{14} fd * oi + \beta_{15} v + \beta_{16} dummy \tag{6.16}$$

6.8.3 Estimating the Long-run Equilibrium Relationship

Having identified the co-integrating vector and imposing weakly exogenous restriction, the results indicate that there is a positive relationship between oil income and output per capita in Iran for all the estimated VECMs. In addition, they indicate that financial development has a negative impact on the economy, which is in contrast to the growth literature. Moreover, the interaction between financial development and oil income has a negative impact on the economy. It can be concluded from the results that whenever oil income is sufficient in Iran it relaxes the financial system and can provide enough money for the government to keep the interest rate artificially low and finance its budget. On the other hand, when the oil revenue is low the government faces difficulty in financing its expenditure, ending up with a very tight budget. It is worth mentioning that for the last 12 years (2003-2015), Iran has faced sanctions and had difficulty selling her oil; therefore, the government revenue from oil has been quite low. It should be mentioned that the error correction terms are negative and significant for all models as required, thereby suggesting that the co-integration relationship is accurate, as reported in Table (6.17).

Table (6.17) Results of Speed of Adjustment and Co-integration

Models	Speed of Adjustment	T-Statistics
VECM 1	-0.024228	1.95399**
VECM 2	-0.033849	1.81718*
VECM 3	-0.14747	0.147
VECM 4	-0.121720	2.31705**

*, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

The result of co-integration is reported in Table (6.18). As can be seen from the table, oil income has a positive impact on output per capita in all models apart from the third model where PRIVY is a proxy for financial development similarly to the result of the ARDL model considering PRIVY as an index for financial development. This indicates the inefficiency of allocating credit to the private sector in Iran. Interestingly, financial development has a negative impact, and also when the interaction between financial development and oil income is considered, the effect is negative. This explains the fact that the financial system cannot successfully invest income from oil. In our model, we consider volatility to be a weakly exogenous variable that seems to have a negative impact on output per capita. Needless to say, the results indicate that political crises had a negative impact on the level of output per capita. The error-correction relationship is as follows:

Table (6.18) Results of Long-run Relationship in VECM

Variables	Case 1	T-Stat	Case 2	T-Stat	Case 3	T-Stat	Case 4	T-Stat
Loi(-1)	0.4136	4.179***	0.22762	1.9821**	0.2190	7.393***	0.1252	2.532**
Inter	-12.758	7.0135***	-0.44192	2.2657**	-1.1774	7.872***	-0.638	3.5221**
CointEq	-0.02422	2.5399**	-0.03384	1.717**	-0.0005	0.1474	-0.121	2.317**
ldepth	-1.1787	6.753***						
lcredit			-7.52013	2.9141**				
lPrivy					-1.7.741	7.866***		
lnfd							-5.1209	2.8307**

*, ** and *** indicate significance at the 10%, 5% and 1% Levels, respectively.

The results of error correction estimation are reported in Table (6.19). As can be seen in the table, in three of the four models a co-integration relationship was confirmed. In addition, in all VECMs apart from the third one, oil has a positive impact on the level of output per capita, and financial development, the interaction between financial development and oil income, volatility and political crises have a negative impact on the level of output. It can be concluded from the results that the financial system is not efficient in Iran and the outcome is in line with the outcome of ARDL estimation. Not surprisingly, PRIVY, which is the domestic credit provided to the private sector, when considered as a proxy for financial development changes the results. This can be translated to the fact that the country does not have the ability to provide sufficient credit to its private sector, which can be considered a reason for the poor performance of the economy in general.

Table (6.19) Error Correction Results

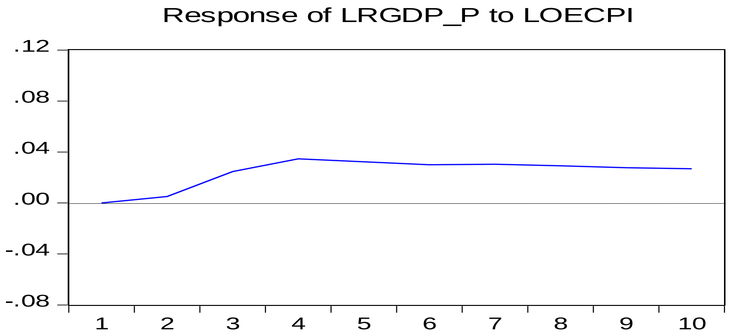
Variables	Case 1	T-Stat	Case 2	T-Stat	Case 3	T-Stat	Case 4	T-Stat
Doi (-1)	0.246	1.9531**	0.1756	1.864**	0.3234	1.7873**	0.1191	1.865**
$dummy$	-0.1255	2.6861**	-0.1420	2.2709**	0.10884	1.7623**	-0.134	2.898**
$volatility$	-0.1477	2.1239**	-0.1274	1.836**	-0.0315	1.743**	-0.046	0.5791
$Dinter$ (-1)	-0.3599	2.4771**	0.002827	0.4698	-0.0213	0.512	-0.123	1.705**
$Dldepth$ (-1)	3.49788	2.5225**						
$Dlcredit$ (-1)			-0.08762	2.0132**				
$Dlprivy$ (-1)					-0.1811	0.4554		
$Dlnfd$ (-1)							-0.8111	1.742**

*, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

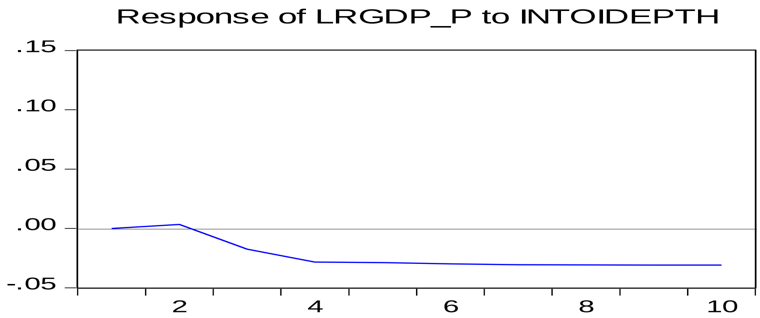
6.8.4 Impulse Response Function

Figure (6.5) indicates that a positive shock to oil income increases real output in Iran. It can be seen that the impacts of shock work themselves through the economy quite quickly. This may be because of the isolation of the financial system in Iran, which makes the economy move up and down rapidly through alterations in domestic or foreign conditions. The figures indicate that a rise in oil revenue increases real output, inflation and the real exchange rate significantly. The Dutch Disease hypothesis cannot be supported for Iran as the increase in the real exchange rate is coupled with a surge in real output. In line with the results of estimations, the interaction between financial development and oil income has a negative impact on output per capita. In addition, in contrast to the growth literature, indexes for financial development do not have a positive impact on output.

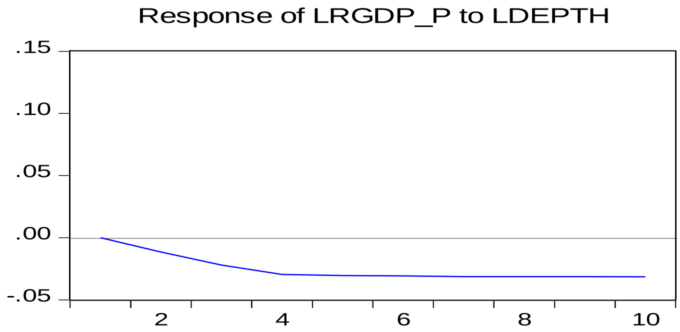
Response to Cholesky One S.D. Innovations



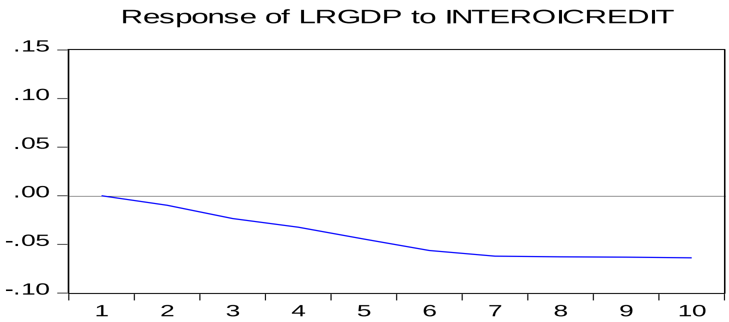
Response to Cholesky One S.D. Innovations



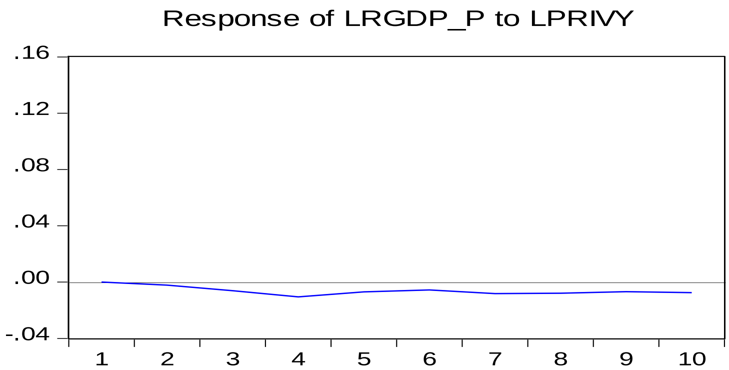
Response to Cholesky One S.D. Innovations



Response to Cholesky One S.D. Innovations



Response to Cholesky One S.D. Innovations



Response to Cholesky One S.D. Innovations

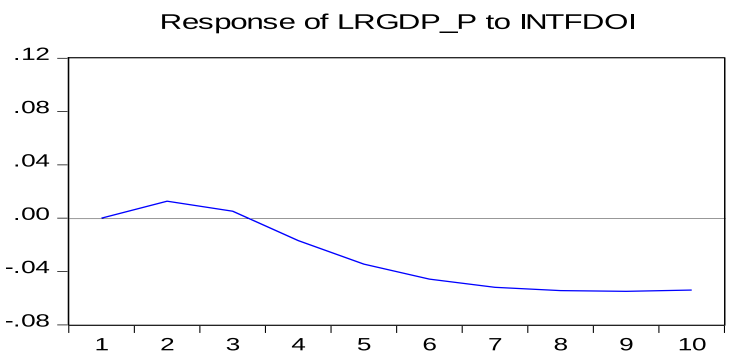


Figure (6.5) Generalized Impulse Response of a Positive One Standard Deviation.

6.9 Summary and Conclusion

This chapter has provided simple models that links together the theoretical framework using an augmented neoclassical model and oil export income in order to investigate empirically the relationship between oil revenue and economic growth in Iran. In particular, it was examined whether oil income has a positive impact on the long-term economic growth of Iran. To test the hypothesis, two different co-integration models, ARDL and VECM, were estimated. The ARDL model indicated that there is a co-integration among variables, which means there is a long-term relationship between variables. The findings indicate that oil income had a positive impact on output per capita in Iran. However, the findings show that the interaction between oil income and the level of financial development in Iran had a negative impact on output per capita, but the financial system in Iran is not very developed and, due to the isolation of the country and tough sanctions, the situation got worse. Moreover, the war and revolution both had negative impacts on the level of output per capita.

The evidence demonstrated from the Johansen co-integration test supports the view that both a long-term and short-term relationship exist between economic growth and oil income in Iran. The findings are in line with studies that support the positive impact of natural resources on economic growth. In addition, the study provides evidence to support the view that the level of financial development will direct the money from oil export to being invested and entering the long-run output equation.

These findings are not consistent with those supporting the so-called “resource curse hypothesis” and Dutch Disease. Overall, the findings in this chapter have significant policy implications for Iran and other major oil exporting countries. The evidence indicates that the level of financial development and oil revenue together play an important role in encouraging economic growth. Thus the development of a financial system can be beneficial for economic growth by improving the quality and quantity of investment.

Appendix 6

The errors of this model (1) are serially independent

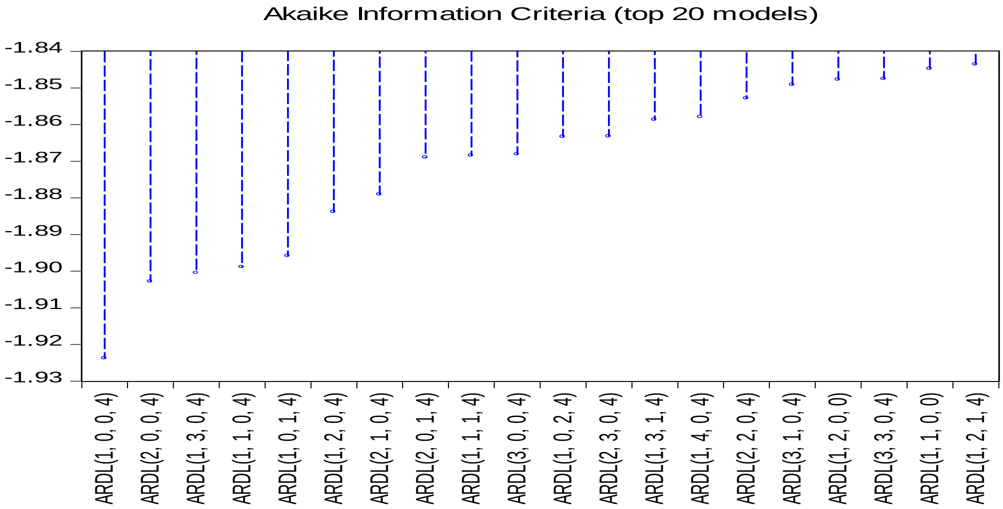
Date: 10/04/17 Time: 17:35
Sample: 1955 2014
Included observations: 47
Q-statistic probabilities adjusted for 1 dynamic regressor

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
. | . |	. | . |	1	0.027	0.027	0.0373	0.847
. | . |	. | . |	2	-0.012	-0.013	0.0449	0.978
. | . |	. | . |	3	-0.062	-0.061	0.2456	0.970
. | . |	. | . |	4	0.063	0.066	0.4556	0.978
.*| . |	.*| . |	5	-0.100	-0.106	1.0061	0.962
**| . |	**| . |	6	-0.278	-0.279	5.3505	0.500
. |*. |	. |*. |	7	0.114	0.146	6.1015	0.528
. | . |	.*| . |	8	-0.060	-0.101	6.3171	0.612
. |*. |	. |*. |	9	0.097	0.087	6.8840	0.649
.*| . |	.*| . |	10	-0.142	-0.120	8.1311	0.616
. | . |	. | . |	11	0.057	-0.012	8.3406	0.683
.*| . |	.*| . |	12	-0.132	-0.191	9.4862	0.661
.*| . |	. | . |	13	-0.091	-0.051	10.042	0.690

. |*. |	. |*. |	14	0.120	0.115	11.040	0.683
. | . |	. | . |	15	0.022	0.028	11.073	0.747
. | . |	.*| . |	16	-0.061	-0.175	11.346	0.788
.*| . |	.*| . |	17	-0.152	-0.112	13.130	0.727
. |*. |	. | . |	18	0.156	0.024	15.059	0.658
. | . |	. |*. |	19	0.054	0.091	15.297	0.704
.*| . |	. | . |	20	-0.082	-0.060	15.865	0.725

*Probabilities may not be valid for this equation specification.

Optimal lag selected according to Akaike model (1)



The errors of this model (2) are serially independent.

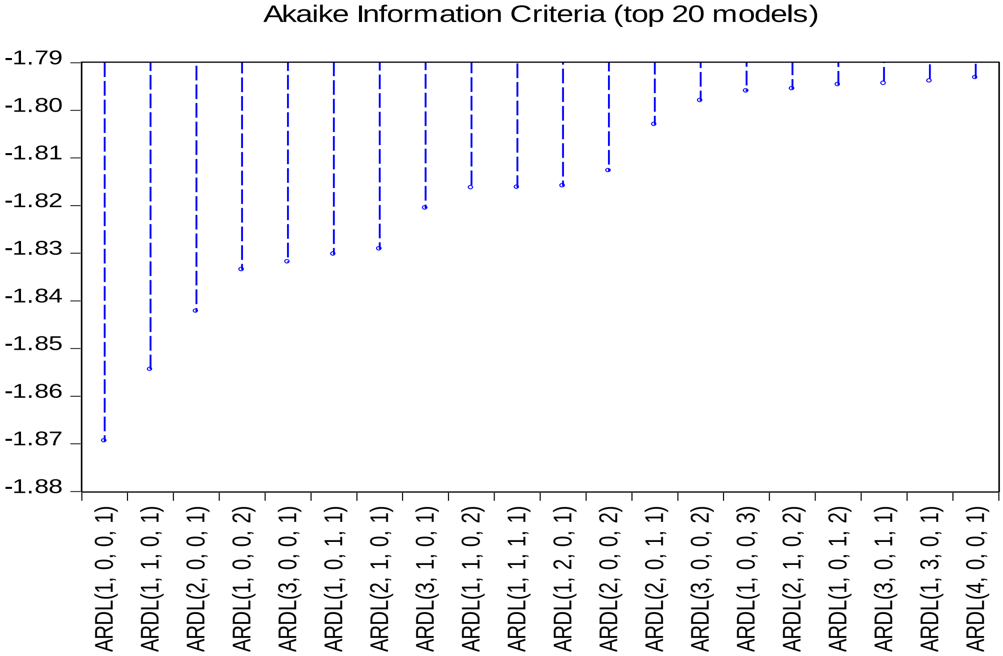
Sample: 1955 2014
Included observations: 54
Q-statistic probabilities adjusted for 1 dynamic regressor

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
. |*. |	. |*. |	1	0.145	0.145	1.1942	0.274
.*| . |	.*| . |	2	-0.074	-0.097	1.5155	0.469
. | . |	. | . |	3	0.002	0.028	1.5156	0.679
. | . |	. | . |	4	0.040	0.029	1.6142	0.806
.*| . |	.*| . |	5	-0.094	-0.107	2.1635	0.826
.*| . |	.*| . |	6	-0.105	-0.070	2.8621	0.826
. |*. |	. |*. |	7	0.191	0.211	5.2160	0.634
. |*. |	. |*. |	8	0.191	0.123	7.6210	0.471
. |*. |	. |*. |	9	0.139	0.141	8.9110	0.446
.*| . |	.*| . |	10	-0.083	-0.116	9.3880	0.496
. | . |	. | . |	11	-0.062	-0.062	9.6603	0.561
**| . |	**| . |	12	-0.292	-0.326	15.813	0.200
.*| . |	. | . |	13	-0.120	0.005	16.880	0.205
. |*. |	. |*. |	14	0.099	0.130	17.627	0.224
. | . |	. | . |	15	0.066	0.045	17.963	0.265
. | . |	. | . |	16	0.033	-0.029	18.048	0.321
. | . |	.*| . |	17	-0.051	-0.152	18.259	0.373
. | . |	. | . |	18	0.053	-0.010	18.495	0.423
. | . |	. |*. |	19	-0.042	0.116	18.645	0.480

.*| . |	. | . |	20	-0.171	0.005	21.248	0.383
.*| . |	. | . |	21	-0.076	0.042	21.777	0.412
. | . |	.*| . |	22	0.024	-0.143	21.832	0.470
. |*. |	. |*. |	23	0.171	0.089	24.673	0.367
. | . |	.*| . |	24	-0.023	-0.114	24.724	0.421

*Probabilities may not be valid for this equation specification.

Optimal lag selected according to Akaike model (2)



The errors of this model (3) are serially independent.

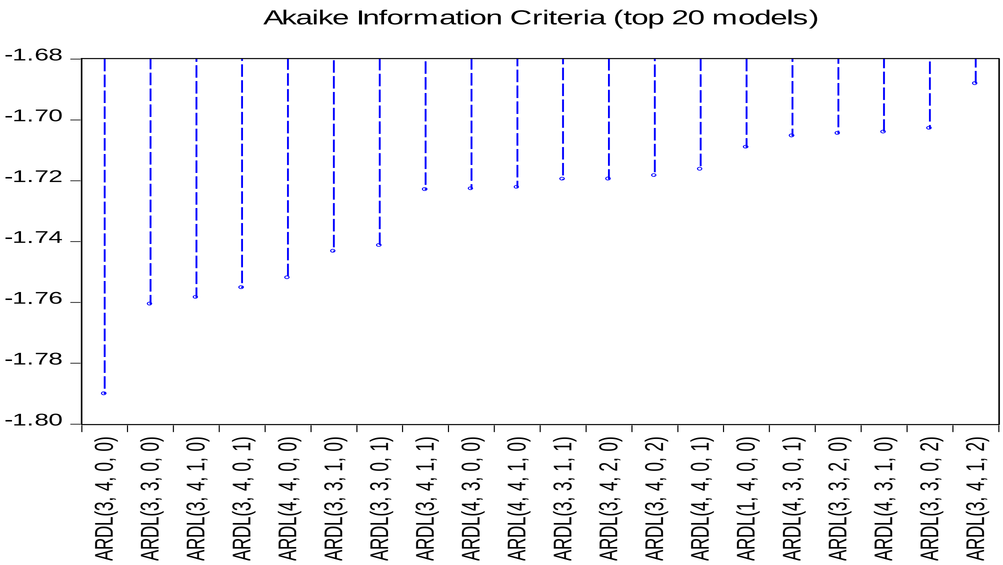
Sample: 1955 2014
Included observations: 55
Q-statistic probabilities adjusted for 3 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
. | . |	. | . |	1	-0.054	-0.054	0.1671	0.683
.*| . |	.*| . |	2	-0.089	-0.092	0.6375	0.727
.*| . |	**| . |	3	-0.203	-0.215	3.1102	0.375
. | . |	. | . |	4	0.007	-0.031	3.1134	0.539
. | . |	.*| . |	5	-0.021	-0.067	3.1415	0.678
. | . |	.*| . |	6	-0.063	-0.124	3.3959	0.758
. |*. |	. | . |	7	0.078	0.051	3.7964	0.803
. | . |	.*| . |	8	-0.044	-0.079	3.9268	0.864
. | . |	. | . |	9	0.006	-0.033	3.9292	0.916
. |*. |	. |*. |	10	0.132	0.156	5.1475	0.881
. | . |	.*| . |	11	-0.053	-0.073	5.3458	0.913
.*| . |	.*| . |	12	-0.192	-0.197	8.0249	0.783
.*| . |	.*| . |	13	-0.174	-0.163	10.284	0.671
. |*. |	. | . |	14	0.121	0.009	11.407	0.654
. | . |	. | . |	15	0.045	-0.058	11.567	0.711
. |*. |	. | . |	16	0.093	0.051	12.262	0.726
. |*. |	. |*. |	17	0.083	0.090	12.825	0.748
. | . |	. | . |	18	0.011	0.017	12.834	0.801
.*| . |	. | . |	19	-0.076	-0.027	13.343	0.821
. | . |	. | . |	20	-0.039	-0.009	13.479	0.856
.*| . |	.*| . |	21	-0.107	-0.160	14.542	0.845

. |*. |	. |*. |	22	0.104	0.136	15.568	0.837
. | . |	. | . |	23	0.017	0.043	15.595	0.872
. | . |	.*| . |	24	-0.011	-0.150	15.607	0.902

*Probabilities may not be valid for this equation specification.

Optimal lag selected according to Akaike model (3)

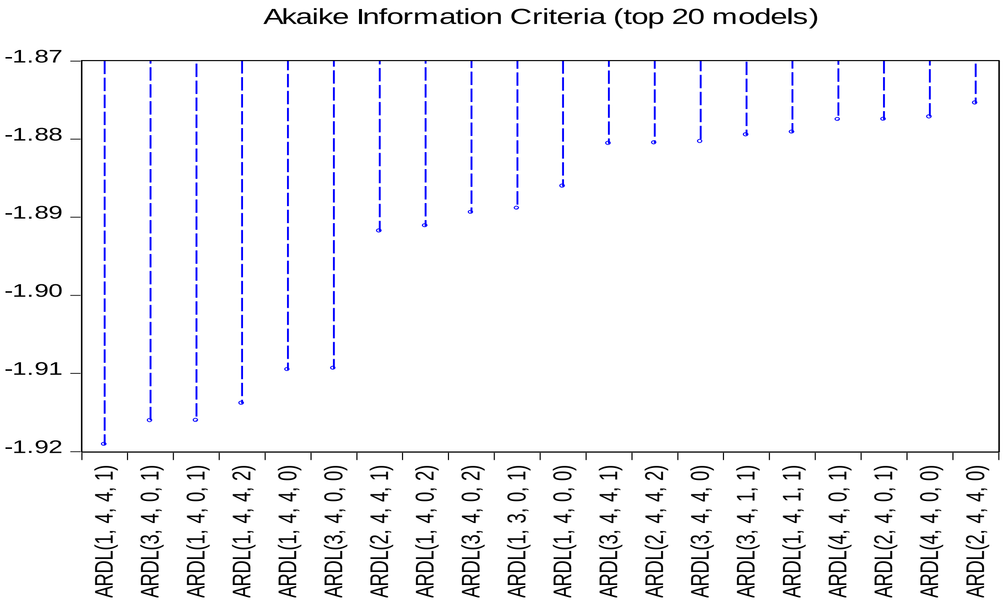


The errors of this model (4) are serially independent.

Q-statistic probabilities adjusted for 1 dynamic regressor

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.*| . |	.*| . |	1	-0.136	-0.136	1.0592	0.303
.*| . |	.*| . |	2	-0.153	-0.175	2.4264	0.297
. | . |	. | . |	3	0.013	-0.037	2.4362	0.487
. | . |	. | . |	4	-0.026	-0.060	2.4775	0.649
. | . |	. | . |	5	-0.032	-0.052	2.5395	0.771
.*| . |	**| . |	6	-0.189	-0.230	4.8009	0.570
. |*. |	. | . |	7	0.080	-0.008	5.2095	0.634
.*| . |	.*| . |	8	-0.072	-0.154	5.5502	0.697
. |*. |	. | . |	9	0.079	0.045	5.9748	0.742
. | . |	.*| . |	10	-0.048	-0.109	6.1334	0.804
. | . |	. | . |	11	0.046	0.030	6.2794	0.854
.*| . |	.*| . |	12	-0.104	-0.204	7.0650	0.853
.*| . |	.*| . |	13	-0.113	-0.157	8.0123	0.843
. |** |	. |*. |	14	0.238	0.092	12.298	0.582
. | . |	. | . |	15	0.030	0.072	12.366	0.651
. | . |	. | . |	16	-0.034	-0.021	12.456	0.712
. | . |	. | . |	17	-0.038	-0.029	12.575	0.764
. | . |	. | . |	18	0.067	-0.020	12.952	0.794
. | . |	. | . |	19	0.056	0.072	13.222	0.827
.*| . |	.*| . |	20	-0.168	-0.101	15.720	0.734
.*| . |	**| . |	21	-0.191	-0.248	19.077	0.580
. |*. |	. | . |	22	0.129	0.032	20.649	0.543
. |*. |	. | . |	23	0.077	-0.004	21.226	0.567
. | . |	. | . |	24	-0.027	0.011	21.300	0.621

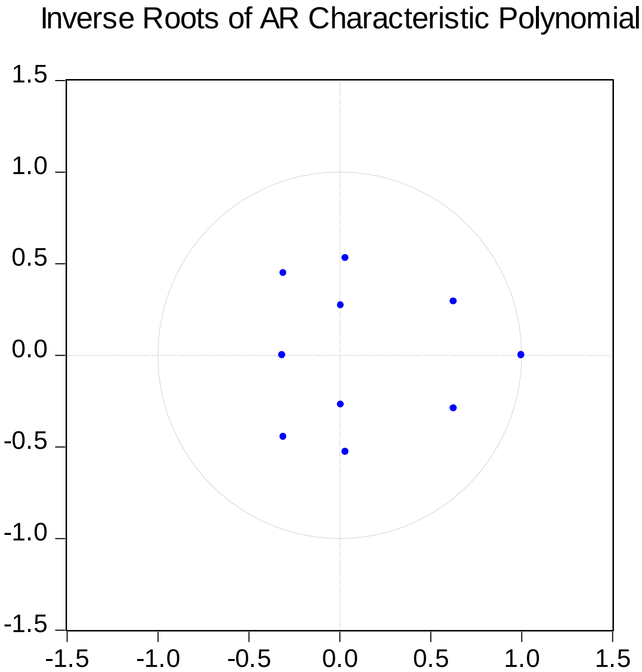
Optimal lag selected according to Akaike model (4)



Weak exogeneity

Co-integration Restrictions:
A(5,1)=0
Convergence achieved after 137 iterations.
Not all co-integrating vectors are identified.
LR test for binding restrictions (rank = 1):

Chi-square(1)	30.65224
Probability	0.000000



Chapter Seven
CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

The impact of oil revenue on economic growth is an issue that has captured researchers' attention for a long period. Empirical studies most of the time use cross-sectional studies to find the impact of oil revenue on economic growth in a regression analysis. Although natural resources are not a factor of production in growth theories, it is important to say that including any natural resources, particularly oil, has a role in determining the long-term economic growth in either a neoclassical or endogenous growth framework. However, in a neoclassical growth model the rate of growth is determined by the exogenous population growth and technological improvements. On the other hand, endogenous growth theories explain growth in a framework where economic growth is determined within the economy itself and the rate of growth is determined by human capital, R&D, innovation etc.

Yet the Solow model remains very much in use in empirical studies on growth. Scholars have used different augmented Solow models to explain other factors that can have a substantial impact on economic growth. In the same line of research, this study has used an augmented neoclassical model to show how oil revenues can enter the long-term output. The study indicates that if oil does not provide a temporary income, it can enter the long-term output through the capital accumulation process. However, it should be mentioned that the role of financial development in the process of converting money from oil to efficient investment is very important. Therefore, this study took into account the impact of financial development on growth as well.

This thesis has estimated two different co-integration models for the Iranian economy bearing in mind that there was a long run relationship between oil income and economic growth over the course of the period 1955-2014. The purpose of this chapter is to draw conclusions on the theoretical and empirical results and related policy implications and recommendations. Moreover, the contributions of this research are explained. Finally, the limitations that the researcher faced and some suggestions for further research are presented.

7.2 Summary of the Study

From a theoretical point of view, natural resource endowments, like any other factor of production, should have a positive impact on economic growth and did have in the nineteenth century. However, the empirical studies in the twentieth century demonstrated an opposite view. Following studies indicating the negative impact of natural resources and economic growth, the resource curse hypothesis was born, indicating that countries endowed with natural resources grow more slowly than those without natural resources. There is a vast body of literature supporting the resource curse hypothesis. However, Esfahani et al. (2014) developed a theoretical framework showing that oil income has a positive impact on economic growth in the major oil exporting countries. This study followed Esfahani et al. (2014) by including financial development, its interaction with oil income and volatility to investigate the impact of oil income on the Iranian economy.

In order to apply a growth model and have a theoretical framework to test the data empirically, Chapter Two delivers an overview of growth theories from the Harrod-Domar model to the more recent theories such as endogenous and augmented Solow models. It can be concluded that natural resources have played an important role in the economic growth of many of today's industrial countries. However, from a theoretical point of view, in none of the growth theories are natural resources a factor of economic growth. In the Solow model, capital accumulation and technology are the main factors of growth, and in endogenous models the key drivers of economic growth are innovation and R&D. However, some other factors have been added to the traditional theories as factors of growth, such as human capital. A number of studies in the literature have used empirical data without any theory. They mostly look at the temporary income and short-term impact of income from natural resources on the exchange rate and government expenditure. Nevertheless, the results are far from conclusive. It seems that the role that natural resources play depends on many aspects, including geographical position, institutional quality, method or techniques used and country.

Studies focusing on the role that revenue from natural resources plays in the economy have mainly used the Solow or endogenous models. Esfahani et al. (2014) developed an empirical growth model for major oil exporting countries. Their model is based on the stochastic Solow model and indicates that in major oil exporting countries, oil can have a positive impact on output production if the growth rate of oil income is greater than the natural growth rate, i.e. population growth and technology growth. Their results are in contrast to the traditional belief regarding the resource curse and the negative association between natural resource abundance and economic growth. In other words, they show that if a country has been producing oil for a long time, and according to reserve to extraction statistics can produce oil in the relative long-term, oil revenues enhance growth. These results have generally been supported by studies such as (Cavalcanti et al. 2011a; Cavalcanti et al. 2011b; Mohaddes and Pesaran 2013).

With regard to the empirical literature, it can be concluded that the majority of the studies have continued to employ neoclassical models with augmentation. Although there is a consensus that a theoretical model of economic growth should move in endogenous framework directions, it has been illustrated that many leading endogenous models, including (Romer 1986; Lucas 1988) are based on very strong assumptions that are not substantiated in applying these models (Solow 2000). Relaxing these strong assumptions would either lead to no endogenous model or infinite time. However, many empirical studies do not rely on any specific growth framework. All in all, the results of all these studies are far from conclusive. Chapter Two reviewed growth frameworks, from the very early ones to the most recent ones, in order to pick a suitable growth theory for developing an appropriate theoretical framework that fits the purpose of this study. This review on growth models helped to establish an analytical framework on how oil can enter the capital accumulation equation. Due to the flexibility of neoclassical growth models and aforementioned reasons, this thesis used a neoclassical growth model to develop a theoretical framework.

It seems the results of natural resource endowments on growth depend on a variety of factors, such as the econometric techniques used, assumptions, proxies of natural resource abundance, country or set of countries, social and political situations in countries and even the geographical situation of countries, among many others. Moreover, the results of analysing the growth effects of natural resources vary from country to country. A review of theories explaining the resource curse and channels through which the resource curse can be felt and some empirical studies were presented in Chapter Three. These studies contribute considerably to knowledge in the area of economic growth and the resource curse. They can be divided into two different groups: one group studying the political economy of the resource curse and the other one looking at the curse from an economic perspective. From the political point of view, resource endowments generate rent-seeking activities, corruption, civil war, poor-quality institutions etc., all of which dampen economic growth. From the economic point of view, the most common explanation of the so-called "resource curse" is the Dutch Disease. Chapter Three explained the Dutch Disease, where, with a boom in natural resource prices, the inflow of foreign currency increases, which leads to currency appreciation. This phenomenon makes the country's other products more expensive in the export sector. It is worth mentioning that Dutch Disease which could be translated to a stronger currency is not inherently a worsening factor. The important issue is that the economy can be adjusted by appropriate policies.

The analysis of literature in Chapters Two and Three indicated that the majority of studies on growth and natural resources have focused on the short-term impact of natural resources. In addition, they mainly used cross-sectional analysis. Therefore, there is a scarcity of literature based on the long-term relationship of resource endowments and growth and using different econometric approaches to cross-sectional analysis. As a result, there is a need to narrow the gap by analysing the long-term role that oil has played in a country that was the first oil producer in the Middle East. Furthermore, the review of empirical studies helped to decide on the applied econometric methods, and the main findings of the study.

Following these reviews, Chapter Four included a brief summary of Iran's economic history, with a focus on oil. This started with the time when oil was discovered and covered the evolution of the oil industry in Iran in order to look at the role of oil historically and compare it to econometric results. It was concluded that for all Development Plans (main economic targets of the country) in Iran both before and after the revolution, oil was almost the only source of finance. In other words, what made all the Development Plans in Iran possible were oil endowments. There were also important events in Iran, such as the Islamic revolution and eight-year war with Iraq, which had significant negative effects both on oil income and the development of the country.

In general, it can be said that oil was always the mainstream of the Iranian economy and played a positive role in the country. Needless to say, the economic system of the country changed dramatically between the discovery of oil and 2014. The data presented in this study start from 1955; however, for a historical analysis we go back to the time that oil was discovered in Iran. Oil was discovered in 1908 in Iran but the country's income from oil was insignificant until 1951 when oil was nationalized. Although after nationalization oil exports reached zero due to the embargo on Iranian oil by

Britain and America, after 1970 oil started to play a significant role in the Iranian economy and is still a cornerstone of the economy.

Taking into account a number of theoretical and empirical issues that emerged from reviewing the literature, this research offered a conceptual framework built on the neoclassical model presented in Chapter Five. In the modified version, since the country is one of the major oil exporting ones, it is assumed that all the income from oil is saved, apart from a proportion that is devoted to financial intermediations. In addition, it is assumed the saving will be transformed to investment. Thus, in the capital accumulation function the investment part consists of two parts: investment from the non-oil output of the country and investment from the oil output of the country, which is petrodollars. Furthermore, the study highlights the importance of financial development in converting savings to productive investment and also using interaction terms for the impact of financial development and oil income. Chapter Five also introduces the variables in the study, which are decided based on the theoretical model. Some data analysis also took place to select an econometric approach that fits the nature of the data. The analysis of data suggested the co-integration models that fit the purpose of study and provided a suitable method regarding the unit root test results.

In Chapter Six, based on the data analysis from the previous chapter, the co-integration estimation was selected. This thesis employed co-integration analysis, particularly ARDL and VECM estimations as the preferred econometric approaches. For instance, while cross-country analysis is likely to suffer from omitted variables, the use of a co-integration technique is likely to control for them. In addition, using co-integration models allows endogeneity to be controlled for.

The findings in Chapter Six suggested that oil revenue plays a positive role in the level of output per capita in Iran. On the other hand, the results indicated that volatility, inappropriate government responses (monetary and fiscal policies) to oil income fluctuations and the level of financial development in interaction with oil income have negative impacts. While we believe that the benefits of natural resource endowments could be greater in oil-abundant countries if they adopted appropriate policies and developed good-quality institutions, the findings of this thesis challenge the common belief regarding the negative effects of oil abundance on economic growth.

Both the ARDL and VECM models indicated that there is co-integration among variables in the system. In other words, there is a long-term relationship amongst variables. The variables in the ARDL models were output per capita, oil income and financial development. It is important to mention that oil income was divided into two variables to simplify the analysis. To take into account political events in the country, both the Islamic revolution and eight-year war with Iraq were included in the model as a dummy variable. Four different ARDL models were estimated, and the difference between them was the proxy that was used for financial development. According to ARDL models, oil income has a positive impact on output per capita. In addition, the financial system of Iran (all four indexes for financial development), in contrast to growth literature, does not contribute positively to the economic growth of the country.

Following the estimation of ARDL models to check whether the same result would be obtained using a different technique, four VEC models were estimated. These models used the same variables as that of ARDL models. In addition, the role of volatility in oil prices as a weakly exogenous variable and the interaction between the financial system and oil income were taken into account. The results were in line with the outcome of ARDL models. While the findings indicated that oil income has a positive impact on per capita output the financial system does not contribute positively to the economic growth of the country. Moreover, the interaction between financial development and oil income does not have a positive impact and volatility has a negative impact on growth. Furthermore, the impulse response function indicates that the ups and downs of oil income show themselves in the economy quite fast. This can be explained through the financial system of the country. This is because of the restrictions of financial markets in Iran that curb expenditure-smoothing options; therefore, this causes quick adjustment to both internal and external shocks.

In general, eight co-integration models were estimated. Interestingly, the results of estimations were in line with the historical analysis in Chapter Four. Both historically and econometrically, oil has a positive impact on the level of output per capita. In addition, in line with the historical analysis, econometric results indicate that war and revolution had a negative impact on the performance of the country. The main finding of this research is that oil, which has been produced in Iran for over a century, had a positive impact on the output per capita of the country. This finding is in contrast to the so-called “resource curse hypothesis”, which believes that natural resources have a negative impact on economic growth.

To answer the research questions of the study, it can be said that oil, in the long-term, has a positive impact on the per capita output of a country. In addition, in the short-term, the economy adjusts itself to any alterations of oil revenue quite fast due to the poor financial development and inefficient financial system. Since oil has been and will be produced for a fairly long period, it can be entered the production function of the country. It is worth mentioning that a well-developed financial system can have a positive impact on the output of the country. Governments need to establish a sovereign fund to be able to deal with the given natural resources' income volatilities.

7.3 Related Policy Implications and Recommendations

From the policy perspective, this thesis suggests that income from oil should be invested in long-term investments; therefore, it has a long-term positive impact. In other words, when oil is produced for a relatively long period it will enter the long-term output equation. However, the government should ensure, by adopting suitable policies, that corruption, civil war and other political economy factors do not disturb this process. This is closely associated with the quality of institutions, the efficiency of the financial system and the infrastructure of the country. In addition, in order to use the revenue from oil effectively, an Oil Stabilization Fund is necessary, a policy that has been adopted by all successful oil producing countries. Appropriate policy implications from the government can act as a shock absorber to deal with volatility from revenues. The above-mentioned policies answer the research questions which were raised in the Introduction Chapter.

Another recommendation that applies to resource-rich countries is to use the comparative advantage they have. For instance, when Norway discovered offshore oil, they simultaneously developed the technology needed to extract it. In other words, Norway not only exports its oil but it also exports the technology and the human capital needed for extracting offshore oil.

Therefore, countries rich in natural resources should develop the technology and human capital that they need for extracting their resources, otherwise they will not be able to gain economically from their natural resources.

In summary, it can be said that the structural change of output, saving and capital have two significant policy implications in Iran. It was found that high domestic saving is an important determinant of economic growth in both short and long term. In addition, saving should be used in order to improve the efficiency of capital accumulation which is an important factor in promoting economic growth in the short term. The use of saving in both provision of capital and infrastructure is necessary in order to promote economic growth in Iran.

Of course resource rich countries are significantly different and what is suitable for a high income and capital abundant country like Kuwait is doubtful to be suitable for low income, scare capital country like Uganda. However, policy issues for other oil based economies can be saving of resource income, high quality institutions, early versus late industrialization and also improving human capital in the country. It is also important to consider how geo-political and geo economic conditions would work together with domestic social and political features to form development results in countries with natural resources endowments.

7.4 Problems and Limitations of the Study

The main difficulty this thesis faced was the reliability and availability of data. The study has used annual instead of seasonal data due to the lack of availability of reliable data. Iran, like most developing countries, is poor at producing reliable data. In addition, due to political issues in 2000, the president announced that data on the main economic indicators were confidential, therefore the researcher had difficulty in collecting data for some years of the study. Moreover, the quality of data is not ideal for most developing countries, which might generate unreliable results from quantitative analysis. However, we hope the above-mentioned problems are not severe enough to invalidate the outcome of this thesis.

7.5 Contribution to Knowledge

The contribution of this research lies in the fact that it supports the evidence in the ongoing debate of the positive impact of oil revenue on the economic growth process, specifically in contrast to the so-called “resource curse”. While previous studies contributed significantly to knowledge in the area of natural resource abundance and economic growth, there is limited coverage of the literature on case studies. When the role of natural resources in an economy is considered studies with the focus on the short-term impact would either look at Norway as a success or Nigeria as a failure. This research; however, looks at Iran as the oldest oil exporting country in the Middle East and tests the hypothesis of a positive impact of oil on the Iranian economy both historically and empirically.

This research has made some contributions to the literature on the relationship between natural resources, particularly oil, and economic growth in Iran over the period 1955-2014. The contributions are summarized as follows:

Firstly, most of the empirical studies on the resource curse have focused on the short-term impact of natural resources on economic growth. Therefore, there is a scarcity of literature analysing the long-term impact. The study applies a new data set over the period 1955-2014 demonstrating that there is a positive long-term impact from oil income on the Iranian economy. Therefore, the findings can be seen as a long-term analysis. Thus, these findings can help to enable a better understanding of the role oil revenue has played in the long term in Iran, specifically in terms of development.

Secondly, the study introduced a theoretical framework in order to test the data empirically. In the developed framework, income from oil enters the saving function of the country. In addition, when the country's savings turn into investment the oil revenue is invested as well. Therefore petrodollars enter the long-term output of the country.

Thirdly, two different co-integrating methods were applied and both came to the same conclusion that there is a long-term positive impact from oil revenue on output per capita. Furthermore, literature on natural resources and economic growth that uses time series usually applies only the Augmented Dickey-Fuller (AFD) or at best the AFD and Phillip -Perron (PP) tests. Several studies, such as Perron (1989) Zivot and Andrews (2002) and Vogelsang and Perron (1998), have indicated that both ADF and PP have high size distortion, which is a chance of rejecting a true null hypothesis or accepting a false null hypothesis. To prevent this issue, this research applies another unit root test: KPSS. Therefore, this research has used the data that have been analysed more carefully than previous researches.

Fourthly, the study analyses the role of oil income in Iran both historically and economically. One chapter is allocated to scrutinizing oil in the economic history of Iran and one chapter looks at it economically, applying two different approaches. Interestingly, the historical results are confirmed by econometric approaches.

7.6 Areas for Further Research

Based on the conclusions and findings of the thesis, it can be suggested that the following are possible areas for further research:

It would be interesting to estimate a model taking into account the important factors of a global economy.

Another important field for further research is developing a more sophisticated model for all the OPEC members, probably including some other important variables, such as interest rate, institutional quality and foreign variables.

In light of the finding that oil was not a curse for the Iranian economy, contrary to the resource curse hypothesis, it would be interesting to employ other econometric methods to investigate the relationship between oil and output per capita.

Although the context of the analysis carried out in this thesis concerns the Iranian economy, the time series data can be readily extended based on country and regions to formulate specific policies for each originating country.

There is also a need for research on the effects of the interactions between different sectors of the economy and the effects of government policies in terms of dealing with volatilities.

The present research focuses on financial development as endogenous and volatility as weakly exogenous factors that impact on the economy. However, there are some other important factors as well that can be included in the model. Furthermore, the study assumes that political economy factors impact on the equilibrium and takes into account their impact indirectly. Further study can include political factors in a model to see if the results change.

In addition, research on natural resources and growth can be grouped according to the frequency of data, and model specification.

Finally, with regard to the general results of the study on the role of oil income in the Iranian economic growth, it would be interesting to develop a comparison study.

Bibliography

Acemoglu, D., Johnson, S., Robinson, J. and Thaicharoen, Y. (2003) Institutional causes, macroeconomic symptoms: volatility, crises and growth. *Journal of monetary economics* 50 (1), 49-123.

Acemoglu, D., Johnson, S. and Robinson, J. A. (2001a) The colonial origins of comparative development: an empirical investigation. *The American Economic Review* 91 (5), 1369-1401.

Acemoglu, D., Johnson, S. and Robinson, J. A. (2001b) *Reversal of fortune: Geography and institutions in the making of the modern world income distribution.* National bureau of economic research.

Acemoglu, D., Johnson, S. and Robinson, J. A. (2002) An african success story: Botswana.

Acemoglu, D. and Ventura, J. (2002) The world income distribution. *Quarterly Journal of Economics*, 659-694.

Aghion, P. and Howitt, P. (1992) A model of growth through creative destruction *Econometrica (1986-1998)* 60 (2), 323.

Alesina, A. and Rodrik, D. (1994) Distributive politics and economic growth. *The Quarterly Journal of Economics* 109 (2), 465-490.

Alexeev, M. and Conrad, R. (2009) The elusive curse of oil. *The Review of Economics and Statistics* 91 (3), 586-598.

Alhajji, A. F. and Huettner, D. (2000) OPEC and other commodity cartels: a comparison. *Energy Policy* 28 (15), 1151-1164.

Alnasrawi, A. (1986) Economic consequences of the Iraq-Iran war. *Third World Quarterly* 8 (3), 869-895.

Alonso, J. A. and Garcimartín, C. (2013) The determinants of institutional quality. more on the debate *Journal of International Development* 25 (2), 206-226.

Amuzegar, J. (1992) The Iranian economy before and after the revolution. *Middle East Journal* 46 (3), 413-425.

Amuzegar, J. (2001) Iran's Post-revolution Planning: The Second Try. *Middle East Policy* 8 (1), 25-42.

Amuzegar, J. (2005) Iran's oil stabilization fund: a misnomer. *Middle East Economic Survey* 48 (47).

Amuzegar, J. (2013) Ahmadinejad's Legacy. *Middle East Policy* 20 (4), 124-132.

Amuzegar, L. and Fekrat, M. A. (1971) *Iran: economic development under dualistic conditions.* Chicago/London: The University of Chicago Press.

Andersen, T. G., Bollerslev, T., Diebold, F. X. and Labys, P. (2001) The distribution of realized exchange rate volatility. *Journal of the American statistical association* 96 (453), 42-55.

Anderson, T. W. and Hsiao, C. (1981) Estimation of dynamic models with error components. *Journal of the American statistical Association* 76 (375), 598-606.

Arezki, R. and Bruckner, M. (2009) *Oil rents, corruption, and state stability: Evidence from panel data regressions.* Citeseer.

Arezki, R. and Van der Ploeg, R. (2007) Can the natural resource curse be turned into a blessing? The role of trade policies and institutions. *IMF Working papers*, 1-34.

Arora, V., Pedro, G. and Lee, J. (2013) Not all oil price shocks are alike: A neoclassical perspective. *US Energy and Information Administration*.

Arrow, K. J. (1962) The Economic Implications of Learning by Doing. *The Review of Economic Studies* 29 (3), 155-173.

Askari, H. (2007) *Middle East oil exporters: what happened to economic development?* Edward Elgar Publishing.

Asteriou, D. and Hall, S. G. (2007) Applied econometrics: a modern approach, revised edition. *Hampshire: Palgrave Macmillan*.

Asteriou, D. and Hall, S. G. (2011) *Applied econometrics.* 2nd edition. Basingstoke;New York;: Palgrave Macmillan.
Auty, R. and Evans, D. (1994) Trade and industrial policy for sustainable resource-based development: policy issues, achievements and prospects. United Nations Conference for Trade and Development.
Auty, R. M. (1993) *Sustaining development in mineral economies: the resource curse thesis.* New York;London;: Routledge.
Auty, R. M. (2001a) The political economy of resource-driven growth. *European Economic Review* 45 (4), 839-846.
Auty, R. M. (2001b) *Resource abundance and economic development.* Oxford University Press.
Ayres, R. U. and Warr, B. (2010) *The economic growth engine: how energy and work drive material prosperity.* Edward Elgar Publishing.
Bahmani-Oskooee, M. (1996) Source of stagflation in an oil-producing country: evidence from Iran. *Journal of Post Keynesian Economics* 18 (4), 609-620.
Baland, J.-M. and Francois, P. (2000) Rent-seeking and resource booms. *Journal of Development Economics* 61 (2), 527-542.
Baldwin, R. E. (1966) *Economic development and export growth: a study of Northern Rhodesia, 1920-1960.* Univ of California Press.
Bamberg, J. H. (1994) The history of the British Petroleum company. *Cambridge Books*.
Barro, R. J. and Lee, J.-W. (1994) *Data set for a panel of 138 countries*. Harvard Univ.
Barro, R. J. and Sala-i-Martin, X. (1995) Economic growth.
Behrman, J. R. (1987) Commodity price instability and economic goal attainment in developing countries. *World Development* 15 (5), 559-573.
Berument, M. H., Ceylan, N. B. and Dogan, N. (2010) The impact of oil price shocks on the economic growth of selected MENA countries. *The Energy Journal*, 149-176.
Bhattacharya, P. C. and Sivasubramanian, M. (2003) Financial development and economic growth in India: 1970–1971 to 1998–1999. *Applied Financial Economics* 13 (12), 925-929.
Binder, M. and Pesaran, M. H. (1999) Stochastic growth models and their econometric implications. *Journal of Economic Growth* 4 (2), 139-183.
Birdsall, N., Pinckney, T. and Sabot, R. (2000) *Natural resources, human capital, and growth. Carnegie Endowment Working Papers*.
Blattman, C., Hwang, J. and Williamson, J. G. (2007) Winners and losers in the commodity lottery: The impact of terms of trade growth and volatility in the Periphery 1870–1939. *Journal of Development economics* 82 (1), 156-179.
Bond, E. W., Wang, P. and Yip, C. K. (1996) A general two-sector model of endogenous growth with human and physical capital: balanced growth and transitional dynamics. *journal of economic theory* 68 (1), 149-173.
Bravo-Ortega, C. and De Gregorio, J. (2007) The relative richness of the poor? Natural resources, human capital, and economic growth. *Lederman and Maloney*, 71-103.
British Petroleum (2016) *BP Statistical Review*

ofWorld Energy

British Petroleum (*2016). https://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review-2016/bp-statistical-review-of-world-energy-2016-full-report.pdf* Accessed 25 January 2017.
Brunnschweiler, C. N. (2008) Cursing the blessings? Natural resource abundance, institutions, and economic growth. *World development* 36 (3), 399-419.
Brunnschweiler, C. N. and Bulte, E. H. (2008) The resource curse revisited and revised: A tale of paradoxes and red herrings. *Journal of Environmental Economics and Management* 55 (3), 248-264.

Bulte, E. H., Damania, R. and Deacon, R. T. (2005) Resource intensity, institutions, and development. *World development* 33 (7), 1029-1044.
Caselli, F., Esquivel, G. and Lefort, F. (1996) Reopening the convergence debate: a new look at cross-country growth empirics. *Journal of economic growth* 1 (3), 363-389.
Cass, D. (1965) Optimum growth in an aggregative model of capital accumulation. *The Review of economic studies* 32 (3), 233-240.
Cavalcanti, T., Mohaddes, K. and Raissi, M. (2012) *Commodity price volatility and the sources of growth*. Rochester.
Cavalcanti, T. V. d. V., Mohaddes, K. and Raissi, M. (2011a) Does oil abundance harm growth? *Applied economics letters* 18 (10/12), 1181-1184.
Cavalcanti, T. V. d. V., Mohaddes, K. and Raissi, M. (2011b) Growth, development and natural resources: new evidence using a heterogeneous panel analysis. *The quarterly review of economics and finance* 51 (4), 305-318.
Chong, A. and Calderon, C. (2000) Institutional quality and income distribution. *Economic Development and Cultural Change* 48 (4), 761-786.
Collier, P. and Hoeffler, A. (1998) On economic causes of civil war. *Oxford economic papers* 50 (4), 563-573.
Collier, P. and Hoeffler, A. (2004) Greed and grievance in civil war. *Oxford economic papers* 56 (4), 563-595.
Collier, P. and Laroche, C. (2014) *If we want the full benefit from resources; this is what we need*.
Corden, W. M. (1984) Booming sector and Dutch disease economics: survey and consolidation. *oxford economic Papers* 36 (3), 359-380.
Corden, W. M. and Neary, J. P. (1982) Booming sector and de-industrialisation in a small open economy. *The economic journal* 92 (368), 825-848.
Davis, G. A. (1995) Learning to love the Dutch disease: Evidence from the mineral economies. *World development* 23 (10), 1765-1779.
Davis, J., Ossowski, R., Daniel, J. and Barnett, S. (2001) OTHER TOPICS-Oil Funds: Problems Posing as Solutions? *Finance and Development-English Edition* 38 (4), 56-59.
Davis, J., Ossowski, R., Daniel, J. and Barnett, S. (2003a) Stabilization and savings funds for nonrenewable resources: experience and fiscal policy implications. *Fiscal policy formulation and implementation in oil-producing countries*, 273-315.
Davis, M. J. M., Fedelino, M. A. and Ossowski, M. R. (2003b) *Fiscal policy formulation and implementation in oil-producing countries.* International Monetary Fund.
Delacroix, J. (1977) The export of raw materials and economic growth: a cross-national study. *American Sociological Review*, 795-808.
Diamond, D. W. (1984) Financial intermediation and delegated monitoring. *The Review of Economic Studies* 51 (3), 393-414.
Diamond, P. A. (1965) National debt in a neoclassical growth model. *The American Economic Review* 55 (5), 1126-1150.
Dickey, D. A. and Fuller, W. A. (1979) Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American statistical association* 74 (366a), 427-431.
Ding, N. and Field, B. C. (2005) Natural Resource Abundance and Economic Growths. *Land Economics* 81 (4), 496-502.
Domar, E. D. (1946) Capital expansion, rate of growth, and employment. *Econometrica, Journal of the Econometric Society*, 137-147.
Domar, E. D. (1947) Expansion and employment. *The American Economic Review* 37 (1), 34-55.
Dritsakis, N., Varelas, E. and Adamopoulos, A. (2006) The main determinants of economic growth: An empirical investigation with Granger causality analysis for Greece. *European Research Studies Journal* 9 (3-4), 47-58.

Durlauf, S. N., Johnson, P. A. and Temple, J. R. (2005) Growth econometrics. *Handbook of economic growth* 1, 555-677.
El-Anashasy, A. (2006) Oil prices, fiscal policy, and Venezuela's economic growth. *Working Paper, University of Washington.*
Eltony, M. N. and Al-Awadi, M. (2001) Oil price fluctuations and their impact on the macroeconomic variables of Kuwait: a case study using a VAR model. *International Journal of Energy Research* 25 (11), 939-959.
Emami, A. (1980) *Oil and Iranian development*.
Enders, W. (2004) Applied econometric time series, by walter. *Technometrics* 46 (2), 264.
Engle, R. F. and Granger, C. W. (1987) Co-integration and error correction: representation, estimation, and testing. *Econometrica: journal of the Econometric Society*, 251-276.
Ersel, H. and Kandil, M. (2006) Financial development and economic growth in the MENA countries. *Contributions to Economic Analysis* 278, 103-136.
Esfahani, H. S., Mohaddes, K. and Pesaran, M. H. (2013) Oil exports and the Iranian economy. *The quarterly review of economics and finance* 53 (3), 221-237.
Esfahani, H. S., Mohaddes, K. and Pesaran, M. H. (2014) An empirical growth model for major oil exporters. *Journal of Applied Econometrics* 29 (1), 1-21.
Esfahani, H. S. and Pesaran, M. H. (2009) The Iranian economy in the twentieth century: A global perspective. *Iranian Studies* 42 (2), 177-211.
Esfahani, H. S. and Ramírez, M. T. (2003) Institutions, infrastructure, and economic growth. *Journal of Development Economics* 70 (2), 443-477.
Farzanegan, M. R. and Markwardt, G. (2009) The effects of oil price shocks on the Iranian economy. *Energy Economics* 31 (1), 134-151.
Feridun, M. (2010) Unit Roots, Structural Breaks and Cointegration Analysis: A review of the Available Processes and Procedures and an Application. *Conference presentation at the Macroeconomics and Financial Economics Workshop: Recent Developments in Theory and Empirical Modelling workshop.*
Ferrier, R. W. and Bamberg, J. H. (1982) *The history of the British Petroleum company: Volume 1, The developing years, 1901-1932.* Vol. 1. Cambridge University Press.
Foon Tang, C. (2011) An exploration of dynamic relationship between tourist arrivals, inflation, unemployment and crime rates in Malaysia. *International Journal of Social Economics* 38 (1), 50-69.
Fosu, A. K. (1996) Primary exports and economic growth in developing countries. *The World Economy* 19 (4), 465-475.
Frankel, J. A. (2010) *The natural resource curse: a survey.* National Bureau of Economic Research.
Frankel, M. (1962) The production function in allocation and growth: a synthesis. *The American Economic Review* 52 (5), 996-1022.
Garratt, A., Lee, K., Hashem Pesaran, M. and Shin, Y. (2003) A long run structural macroeconomic model of the UK. *The Economic Journal* 113 (487), 412-455.
Garratt, A., Lee, K., Pesaran, M. H. and Shin, Y. (2012) *Global and national macroeconometric modelling: a long-run structural approach.* Oxford University Press.
Gelb, A. H. (1988) *Oil windfalls: Blessing or curse?* Oxford University Press.
Ghasimi, M. R. (1992) The Iranian economy after the revolution: An economic appraisal of the five-year plan. *International Journal of Middle East Studies* 24 (4), 599.
Goldsmith, R. W. (1969) *Financial structure and development.* Vol. 9. London: Yale U.P.
Gozalo, P. L. (1993) A consistent model specification test for nonparametric estimation of regression function models. *Econometric Theory* 9 (03), 451-477.
Graham, R. (1979) Iran: The Illusion of Power, rev. ed. *London: Croom Helm*, 183.
Granger, C. W. (1983) *Co-integrated variables and error-correcting models*. Discussion Paper 83-13. Department of Economics, University of California at San Diego.

Granger, C. W. and Weiss, A. A. (1983) Time series analysis of error-correction models. *Studies in Econometrics, Time Series, and Multivariate Statistics*, 255-278.
Gregory, R. G. (1976) Some implications of the growth of the mineral sector. *Australian Journal of Agricultural and Resource Economics* 20 (2), 71-91.
Grossman, G. and Helpman, E. (1991a) *Innovation and growth in the world economy*. Cambridge, ma: mit Press.
Grossman, G. M. and Helpman, E. (1991b) Quality ladders in the theory of growth. *The Review of Economic Studies* 58 (1), 43-61.
Grossman, G. M. and Helpman, E. (1993) *Endogenous innovation in the theory of growth.* National Bureau of Economic Research.
Gylfason, T. (2000) Resources, agriculture, and economic growth in economies in transition. *Kyklos* 53 (4), 337-361.
Gylfason, T. (2001) Natural resources, education, and economic development. *European economic review* 45 (4), 847-859.
Gylfason, T. (2002) Mother earth: ally or adversary? *WORLD ECONOMICS-HENLEY ON THAMES-* 3 (1), 7-24.
Gylfason, T., Herbertsson, T. T. and Zoega, G. (1999) A mixed blessing. *Macroeconomic dynamics* 3 (02), 204-225.
Gylfason, T. and Zoega, G. (2006) Natural resources and economic growth: The role of investment. *The World Economy* 29 (8), 1091-1115.
Hacche, G. (1979) *The theory of economic growth: an introduction.* London;etc.;: Macmillan.
Hakimian, H. (1999) Institutional change and macroeconomic performance in Iran two decades after the Revolution (1979-1999). *Economic Research Forum Working Papers.*
Hamilton, J. D. (1994) *Time series analysis.* Vol. 2. Princeton university press Princeton.
Hamilton, J. D. (2011) *Historical oil shocks.* National Bureau of Economic Research.
Harford, T. and Klein, M. (2005) Aid and the resource curse. *Public Policy Journal* 291, 1-4.
Harrod, R. F. (1939) An essay in dynamic theory. *The economic journal* 49 (193), 14-33.
Harrod, R. F. (1948) Towards a dynamic economics.
Hartwick, J. M. (1977) Intergenerational equity and the investing of rents from exhaustible resources. *The american economic review* 67 (5), 972-974.
Hausmann, R. and Rigobon, R. (2003) *An alternative interpretation of the'resource curse': Theory and policy implications.* National Bureau of Economic Research.
Herb, M. (2005) No representation without taxation? Rents, development, and democracy. *Comparative Politics*, 297-316.
Hicks, J. R. (1969) A theory of economic history. *OUP Catalogue*.
Hidalgo, J. (1992) A general non-parametric misspecification test. *Manuscript, London School of Economics*.
Hirschman, A. O. (1958) *The strategy of economic development.*
Hodler, R. (2006) The curse of natural resources in fractionalized countries. *European Economic Review* 50 (6), 1367-1386.
Holmøy, E. (2009) Mineral rents and social policy: The case of the Norwegian government oil fund. *Financing Social Policy.* Springer. 183-212.
Humphreys, M., Sachs, J. and Stiglitz, J. E. (2007) *Escaping the resource curse.* Cambridge Univ Press.
Humphreys, M. and Sandbu, M. E. (2007) The political economy of natural resource funds. *Escaping the resource curse*, 194-233.
Isham, J., Woolcock, M., Pritchett, L. and Busby, G. (2005) The varieties of resource experience: natural resource export structures and the political economy of economic growth. *The World Bank Economic Review* 19 (2), 141-174.
Islam, N. (1995) Growth empirics: a panel data approach. *The Quarterly Journal of Economics* 110 (4), 1127-1170.
Jackson, J. E. (2005) *A user's guide to principal components.* Vol. 587. John Wiley & Sons.

Jahan-Parvar, M. R. and Mohammadi, H. (2011) Oil prices and real exchange rates in oil-exporting countries: a bounds testing approach *The Journal of Developing Areas* 45 (1), 313-322.
Jalali-Naini, A. R. (2003) Economic growth in Iran: 1950-2000. *Institute for Research and Planning Development, Working Paper*.
Jalilian, H. and Odedokun, M. O. (2000) Equipment and non-equipment private investment: a generalized Solow model. *Applied Economics* 32 (3), 289-296.
Johansen, L. (1959) Substitution versus fixed production coefficients in the theory of economic growth: a synthesis. *Econometrica: Journal of the Econometric Society*, 157-176.
Johansen, S. (1988) Statistical analysis of cointegration vectors. *Journal of economic dynamics and control* 12 (2-3), 231-254.
Johansen, S. and Juselius, K. (1990) Maximum likelihood estimation and inference on cointegration—with applications to the demand for money. *Oxford Bulletin of Economics and statistics* 52 (2), 169-210.
Jolliffe, I. T. (2002) Principal component analysis and factor analysis. *Principal component analysis*, 150-166.
Jones, L. E., Manuelli, R. E. and Stacchetti, E. (1999) *Technology (and policy) shocks in models of endogenous growth.* National bureau of economic research.
Jones Luong, P. and Weinthal, E. (2010) *Oil is not a curse: ownership structure and institutions in Soviet successor states.* Cambridge: Cambridge University Press.
Jones, R. W. (1965) The structure of simple general equilibrium models. *The Journal of Political Economy*, 557-572.
Karl, T. L. (2007) Oil-led development: social, political, and economic consequences. *Encyclopedia of energy* 4, 661-672.
Karshenas, M. and Pesaran, M. H. (1995) Economic reform and the reconstruction of the Iranian economy. *Middle East Journal* 49 (1), 89-111.
Katouzian, H. (1981) *The political economy of modern Iran: Despotism and pseudo-modernism, 1926–1979.* Springer.
Kaufmann, D., Kraay, A. and Mastruzzi, M. (2011) The Worldwide Governance Indicators: Methodology and Analytical Issues. *Hague Journal on the Rule of Law* 3 (2), 220-246.
Keynes, J. M. (1936) *The general theory of interest, employment and money*. London: Macmillan.
Kim, D.-H. and Lin, S.-C. (2017) Human Capital and Natural Resource Dependence. *Structural Change and Economic Dynamics* 40, 92-102.
King, R. G. and Levine, R. (1993a) Finance and growth: Schumpeter might be right. *The quarterly journal of economics*, 717-737.
King, R. G. and Levine, R. (1993b) Finance, entrepreneurship and growth. *Journal of Monetary economics* 32 (3), 513-542.
Kinzer, S. (2003) *All the Shah's men: An American coup and the roots of Middle East terror.* John Wiley & Sons.
Kiviet, J. F. (1995) On bias, inconsistency, and efficiency of various estimators in dynamic panel data models. *Journal of econometrics* 68 (1), 53-78.
Klenow, P. J. and Rodriguez-Clare, A. (1997) The neoclassical revival in growth economics: Has it gone too far? *NBER macroeconomics annual* 12, 73-103.
Knack, S. (2006) Measuring corruption in Eastern Europe and Central Asia: A critique of the cross-country indicators. *World Bank Policy Research Working Paper* (3968).
Knowles, S. and Owen, P. D. (1995) Health capital and cross-country variation in income per capita in the Mankiw-Romer-Weil model. *Economics Letters* 48 (1), 99-106.
Koopmans, T. C. (1965) On the concept of optimal economic growth.
Kruger, A. O., Schiff, M. and Valdes, A. (1991) *Political Economy of Agricultural Pricing Policies, 3 volumes*. Baltimore: Johns Hopkins University Press.

Krugman, P. (1987) The narrow moving band, the Dutch disease, and the competitive consequences of Mrs. Thatcher: Notes on trade in the presence of dynamic scale economies. *Journal of development Economics* 27 (1-2), 41-55.
Kunčič, A. (2014) Institutional quality dataset. *Journal of institutional economics* 10 (01), 135-161.
Kurtz, M. J. and Schrank, A. (2007) Growth and governance: Models, measures, and mechanisms. *Journal of politics* 69 (2), 538-554.
Kuznets, S. (1973) Modern economic growth: findings and reflections. *The American economic review* 63 (3), 247-258.
Kwiatkowski, D., Phillips, P. C., Schmidt, P. and Shin, Y. (1992) Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of econometrics* 54 (1-3), 159-178.
Landes, D. S. (1998) *The wealth and poverty of nations: why some are so rich and some so poor.* London: Little, Brown.
Lane, P. R. and Tornell, A. (1996) Power, Growth, and the Voracity Effect. *Journal of Economic Growth* 1 (2), 213-241.
Lautenschlager, W. (1986) The Effects of an Overvalued Exchange Rate on the Iranian Economy, 1979-84. *International Journal of Middle East Studies* 18 (1), 31-52.
Lederman, D. and Maloney, W. (2002) *Open questions about the link between natural resources and economic growth: Sachs and Warner revisited.* Vol. 141. Banco Central de Chile.
Lederman, D. and Maloney, W. F. (2003) Trade structure and growth. *World Bank Policy Research Working Paper* (3025).
Leite, C. A. and Weidmann, J. (1999) Does mother nature corrupt? Natural resources, corruption, and economic growth. *Natural Resources, Corruption, and Economic Growth (June 1999). IMF Working Paper* (99/85).
Lim, C. and McAleer, M. (2001) Cointegration analysis of quarterly tourism demand by Hong Kong and Singapore for Australia. *Applied Economics* 33 (12), 1599-1619.
Long, J. B. D. and Summers, L. H. (1991) Equipment Investment and Economic Growth. *The Quarterly Journal of Economics* 106 (2), 445-502.
Lucas, R. (1988) On the mechanisms of development planning. *Journal of Monetary Economics* 22 (1), 3-42.
Lucas, R. (1998) On the mechanics of economic development. *ECONOMETRIC SOCIETY MONOGRAPHS* 29, 61-70.
Luintel, K. B. and Khan, M. (1999) A quantitative reassessment of the finance–growth nexus: evidence from a multivariate VAR. *Journal of development economics* 60 (2), 381-405.
Lütkepohl, H. (2005) *New introduction to multiple time series analysis.* Springer Science & Business Media.
Lutz, M. (1994) The effects of volatility in the terms of trade on output growth: New evidence. *World Development* 22 (12), 1959-1975.
Mabro, R. and Monroe, E. (1974) Arab wealth from oil: problems of its investment. *International Affairs (Royal Institute of International Affairs 1944-)* 50 (1), 15-27.
Maddala, G. and Wu, S. (2000) Cross-country growth regressions: problems of heterogeneity, stability and interpretation. *applied Economics* 32 (5), 635-642.
Mahadevan, R. and Asafu-Adjaye, J. (2007) Energy consumption, economic growth and prices: A reassessment using panel VECM for developed and developing countries. *Energy Policy* 35 (4), 2481-2490.
Mahdavy, H. (1970) The patterns and problems of economic development in rentier states: the case of Iran. *life* 1000 (1).
Mankiw, N. G. (2007) *Macroeconomics.* Vol. 6th. New York: Worth.
Mankiw, N. G., Romer, D. and Weil, D. N. (1992) A Contribution to the Empirics of Economic Growth. *The Quarterly Journal of Economics* 107 (2), 407-437.

Marshall, A. (1898) *Principles of economics. Vol. 1.* Macmillan And Co., Limited; London.
Matsuyama, K. (1992) Agricultural productivity, comparative advantage, and economic growth. *Journal of economic theory* 58 (2), 317-334.
Mauro, P. (1995) Corruption and growth. *The quarterly journal of economics* 110 (3), 681-712.
McArthur, J. W. and Sachs, J. D. (2001) *Institutions and geography: comment on Acemoglu, Johnson and Robinson (2000).* National bureau of economic research.
McKinnon, R. I. (1973) *Money and capital in economic development.* Washington: Brookings Institution.
Mehlum, H., Moene, K. and Torvik, R. (2006a) Cursed by resources or institutions? *The World Economy* 29 (8), 1117-1131.
Mehlum, H., Moene, K. and Torvik, R. (2006b) Institutions and the resource curse*. *The economic journal* 116 (508), 1-20.
Miguel, E., Satyanath, S. and Sergenti, E. (2004) Economic shocks and civil conflict: An instrumental variables approach. *Journal of political Economy* 112 (4), 725-753.
Mirjalili, S. H. (1993) Buyer's of Iranian Oil. *Etelate Siasi_Eghtesadi* 7 (No 9-10), 88-96.
Modigliani, F. (1970) The life cycle hypothesis of saving and intercountry differences in the saving ratio. *Induction, growth and trade*, 197-225.
Mohaddes, K. and Pesaran, M. (2013) One Hundred Years of Oil Income and the Iranian Economy: A Curse or a Blessing?
Moran, C. (1983) Export fluctuations and economic growth: An empirical analysis. *Journal of Development Economics* 12 (1-2), 195-218.
Naka, A. and Tufte, D. (1997) Examining impulse response functions in cointegrated systems. *Applied economics* 29 (12), 1593-1603.
Neary, J. P. and Van Wijnbergen, S. (1986) Natural resources and the macroeconomy.
Nelson, C. R. and Plosser, C. R. (1982) Trends and random walks in macroeconmic time series: some evidence and implications. *Journal of monetary economics* 10 (2), 139-162.
Ngerman, S. and Sokoloff, K. (2000) Institutions, factor endowments, and paths of development in the new world. *Journal of Economics Perpectives* 14 (3).
Nili, M. and Rastad, M. (2007) Addressing the growth failure of the oil economies: The role of financial development. *The Quarterly Review of Economics and Finance* 46 (5), 726-740.
Nonneman, W. and Vanhoudt, P. (1996) A further augmentation of the Solow model and the empirics of economic growth for OECD countries. *The Quarterly Journal of Economics* 111 (3), 943-953.
North, D. C. (1990) *Institutions, institutional change and economic performance.* Cambridge university press.
Obstfeld, M. and Rogoff, K. S. (1996) *Foundations of international macroeconomics.* Vol. 30. MIT press Cambridge, MA.
Okada, T. (1999) What Does The Solow Model Tell Us About Economic Growth?: Complete and Partial Cross-country Excludability of Technologies. *Unpublished manuscript*.
Olomola, P. A. and Adejumo, A. V. (2006) Oil price shock and macroeconomic activities in Nigeria. *International Research Journal of Finance and Economics* 3 (1), 28-34.
Oman, C. (2006) Uses and Abuses of Governance Indicators. *Centre de Développement de l'OCDE, Paris*.
Organization of the Petroleum Exporting Countries (2017) *Our Mission.* http://www.opec.org/opec_web/en/about_us/23.htm
Papyrakis, E. and Gerlagh, R. (2004) The resource curse hypothesis and its transmission channels. *Journal of Comparative Economics* 32 (1), 181-193.
Patterson, K. D. (2000) *An introduction to applied econometrics.* St. Martin's press.
Perron, P. (1989) The great crash, the oil price shock, and the unit root hypothesis. *Econometrica: Journal of the Econometric Society*, 1361-1401.

Perron, P. and Vogelsang, T. J. (1992) Testing for a unit root in a time series with a changing mean: corrections and extensions. *Journal of Business & Economic Statistics* 10 (4), 467-470.

Pesaran, M. H. and Shin, Y. (1998) An autoregressive distributed-lag modelling approach to cointegration analysis. *Econometric Society Monographs* 31, 371-413.

Pesaran, M. H., Shin, Y. and Smith, R. J. (2001) Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics* 16 (3), 289-326.

Phillips, P. C. and Perron, P. (1988) Testing for a unit root in time series regression. *Biometrika*, 335-346.

Pindyck, R. S. and Rubinfeld, D. L. (1998) *Econometric models and economic forecasts.* Vol. 4. Irwin/McGraw-Hill Boston.

Plan and Budget Organization. (1975) *The revised fifth plan 1973-1978* Tehran: Plan and Budget Organization

Plan organization (1968) *Fourth national development plan of Iran.* Plan and Budget Organization.

Prebisch, R. (1949) *The economic development of Latin America and its principal problems.* UN.

Psacharopoulos, G. and Arriagada, A. (1986) La composition de la population active par niveau dinstruction: une comparaison internationale. *Revue internationale du travail* 125, 617-631.

Raguindin, C. and Reyes, R. G. (2005) The effects of oil price shocks on the Philippine economy: a VAR approach. *University of the Philippines School of Economics*.

Ramsey, F. P. (1928) A mathematical theory of saving. *The economic journal* 38 (152), 543-559.

Rebelo, S. T. (1991) Long-run policy analysis and long-run growth. *Journal of Political Economy* 99 (3), 500-521.

Robinson, J. A., Torvik, R. and Verdier, T. (2006) Political foundations of the resource curse. *Journal of development Economics* 79 (2), 447-468.

Robinson, P. M. (1991) Consistent nonparametric entropy-based testing. *The Review of Economic Studies* 58 (3), 437-453.

Rodriguez, F. and Sachs, J. D. (1999) Why do resource-abundant economies grow more slowly? *Journal of Economic Growth* 4 (3), 277-303.

Rodrik, D. (2007) *One economics, many recipes: globalization, institutions, and economic growth.* Woodstock; Princeton, N.J: Princeton University Press.

Rodrik, D. and ebrary, I. (2003) *In search of prosperity: analytic narratives on economic growth.* Vol. New. Princeton, N.J: Princeton University Press.

Rodrik, D., Subramanian, A. and Trebbi, F. (2004) Institutions rule: the primacy of institutions over geography and integration in economic development. *Journal of economic growth* 9 (2), 131-165.

Roemer, M. (1970) *Fishing for growth: export-led development in Peru, 1950-1967.* Harvard University Press.

Romer, D. and Chow, C. (1996) *Advanced macroeconomic theory.* Mcgraw-hill.

Romer, P. M. (1986) Increasing returns and long-run growth. *The journal of political economy*, 1002-1037.

Romer, P. M. (1990) Endogenous technological change. *Journal of Political Economy* 98 (5), S71-102.

Romer, P. M. (1994) The origins of endogenous growth. *The journal of economic perspectives*, 3-22.

Ross, M. L. (1999) The political economy of the resource curse. *World politics* 51 (02), 297-322.

Ross, M. L. (2012) *The Oil Curse: How Petroleum Wealth Shapes the Development of Nations.* Princeton, NJ: Princeton University Press.

Rostow, W. W. (1960) *The stages of economic growth: a non-Communist manifesto.* Book: Cambridge University Press.
Sachs, J. D. and McArthur, J. W. (2002) Technological advancement and long-term economic growth in Asia. *Technology and the new economy, MIT Press, Cambridge, MA*, 157-185.
Sachs, J. D. and Warner, A. M. (1995a) *Economic convergence and economic policies.* National Bureau of Economic Research.
Sachs, J. D. and Warner, A. M. (1995b) *Natural resource abundance and economic growth.* National Bureau of Economic Research.
Sachs, J. D. and Warner, A. M. (1997) Fundamental sources of long-run growth. *The American economic review* 87 (2), 184-188.
Sachs, J. D. and Warner, A. M. (1999) The big push, natural resource booms and growth. *Journal of development economics* 59 (1), 43-76.
Sachs, J. D. and Warner, A. M. (2001) The curse of natural resources. *European economic review* 45 (4), 827-838.
Sala-i-Martin, X. (1990) *Lecture notes on economic growth (II): Five prototype models of endogenous growth.* National Bureau of Economic Research.
Sala-i-Martin, X. and Subramanian, A. (2003) *Addressing the Natural Resource Curse: An Illustration from Nigeria.* 0898-2937.
Salehi Esfahani, H. (2006) A reexamination of the political economy of growth in the MENA countries. Vol. 278. Emerald Group Publishing Limited. 61-102.
Samuelson, P. A. (1958) An exact consumption-loan model of interest with or without the social contrivance of money. *Journal of political economy* 66 (6), 467-482.
Saunders, M. N. (2011) *Research methods for business students, 5/e.* Pearson Education India.
Schumpeter, J. (1934) Theorie der Wirtschaftlichen Entwicklung. The Theory of Economic Development. Leipzig: Duncker&Humbolt. 1912. *Trans. by R Opie as An inquiry into Profits, Capital, Credit, Interest and the Business Cycle. Cambridge, MA: Harvard University Press*.
Seers, D. (1964) The mechanism of an open petroleum economy. *Social and economic studies*, 233-242.
Sen, A. (2001) *Development as freedom.* Oxford Paperbacks.
Shaffer, B., Ziyadov, T. and ebrary, I. (2012) *Beyond the resource curse.* Vol. 1st. - eBook: University of Pennsylvania Press.
Shaw, E. S. (1973) *Financial deepening in economic development.* New York;London;: Oxford University Press.
Shell, K. (1967) A model of inventive activity and capital accumulation. *Essays on the theory of optimal economic growth*, 67-85.
Sims, C. A. (1980) Macroeconomics and Reality. *Econometrica* 48 (1), 1-48.
Snape, R. H. (1977) Effects of mineral development on the economy. *Australian Journal of Agricultural and Resource Economics* 21 (3), 147-156.
Solow, R. M. (1956) A contribution to the theory of economic growth. *The quarterly journal of economics*, 65-94.
Solow, R. M. (1957) Technical change and the aggregate production function. *The review of Economics and Statistics*, 312-320.
Solow, R. M. (1994) Perspectives on growth theory. *The Journal of Economic Perspectives* 8 (1), 45-54.
Solow, R. M. (1999) Neoclassical growth theory. *Handbook of macroeconomics* 1, 637-667.
Solow, R. M. (2000) *Growth theory: an exposition.* 2nd edition. Oxford;New York;: Oxford University Press.
Solow, R. M. (2001) Applying growth theory across countries. *The World Bank economic review* 15 (2), 283-288.

Stiglitz, J. (1974) Growth with exhaustible natural resources: efficient and optimal growth paths. *The review of economic studies*, 123-137.
Stock, J. H. and Watson, M. W. (1988) Testing for common trends. *Journal of the American Statistical Association* 83 (404), 1097-1107.
Swan, T. W. (1956) Economic growth and capital accumulation. *Economic record* 32 (2), 334-361.
Temple, J. (1998a) Equipment investment and the Solow model. *Oxford Economic Papers* 50 (1), 39-62.
Temple, J. (1999) The new growth evidence. *Journal of economic Literature* 37 (1), 112-156.
Temple, J. R. (1998b) Robustness tests of the augmented Solow model. *Journal of Applied Econometrics* 13 (4), 361-375.
Tollison, R. D. (1982) Rent seeking: A survey. *Kyklos* 35 (4), 575-602.
Tornell, A. and Lane, P. R. (1999) The voracity effect. *american economic review*, 22-46.
Torres, N., Afonso, O. and Soares, I. (2012) Oil abundance and economic growth-A panel data analysis. *Energy Journal* 33 (2), 119-148.
Torvik, R. (2002) Natural resources, rent seeking and welfare. *Journal of development economics* 67 (2), 455-470.
Uğur, A. (2008) Import and economic growth in Turkey: Evidence from multivariate VAR analysis. *Journal of economics and Business* 11 (1-2), 54-75.
Valadkhani, A. (2001) An analysis of Iran's third five-year development plan in the post-revolution era (2000-2005).
Van Der Ploeg, F. and Poelhekke, S. (2009) Volatility and the natural resource curse. *Oxford Economic Papers* 61 (4), 727-760.
Van der Ploeg, F. and Poelhekke, S. (2010) The pungent smell of "red herrings": Subsoil assets, rents, volatility and the resource curse. *Journal of Environmental Economics and Management* 60 (1), 44-55.
Vogelsang, T. J. and Perron, P. (1998) Additional tests for a unit root allowing for a break in the trend function at an unknown time. *International Economic Review*, 1073-1100.
Von Furstenberg, G. M. and Fratianni, M. (1996) Indicators of financial development. *The North American Journal of Economics and Finance* 7 (1), 19-29.
Wade, R. (1992) East Asia's economic success: conflicting perspectives, partial insights, shaky evidence. *World Politics* 44 (02), 270-320.
Waheed, M., Alam, T. and Ghauri, S. P. (2006) Structural breaks and unit root: evidence from Pakistani macroeconomic time series.
Weil, D. N. (2005) *Economic growth.* Boston, London: Addison-Wesley.
Wheeler, D. (1984) Sources of stagnation in sub-Saharan Africa. *World development* 12 (1), 1-23.
Wick, K. and Bulte, E. H. (2006) Contesting resources–rent seeking, conflict and the natural resource curse. *Public Choice* 128 (3-4), 457-476.
Wright, G. and Czelusta, J. (2004) Why economies slow: the myth of the resource curse. *Challenge* 47 (2), 6-38.
Yifu Lin, J. and Nugent, J. B. (1995) Institutions and economic development. *Handbook of development economics* 3, 2301-2370.
Zhou, T., Bonham, C. and Gangnes, B. (2007) Modelling the supply and demand for tourism: a fully identified VECM approach. *University of Hawaii, Department of Economics Working Papers* 200717.
Zivot, E. and Andrews, D. W. K. (2002) Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. *Journal of business & economic statistics* 20 (1), 25-44.